TRACOR™

6500 Tracor Lane, Austin, Texas 78721, AC 512/926-2800

OPERATION AND SERVICE MANUAL

FREQUENCY STANDARD

MODELS 2.5B & 2.5C

SERIAL NO. 459/1232 S-69011

September 1967

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A6-106-76A

INTRODUCTION

This manual contains the information necessary to operate and maintain the Frequency Standard Model 2.5B and Model 2.5C manufactured by Sulzer Laboratories Division, TRACOR, Inc. This information includes physical description, installation procedures, operating procedures, theory of operation, procedures for calibration and alignment, a parts list, and applicable drawings and diagrams required to provide adequate manual support.

All information in this manual applies to both the Model 2.5B and Model 2.5C unless specifically stated otherwise.

This manual is to be used by all personnel operating or servicing the Frequency Standard.

Appendix A contains the operation and service manual for the Power Supply Model 5P. The Power Supply Model 5P is optional equipment supplied on customer request only.

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SECTION I
GENERAL DESCRIPTION

1-1. SCOPE OF SECTION.

1-2. This section describes the purpose and physical characteristics of the Sulzer Laboratories, all-silicon, solid state Frequency Standard Model 2.5B and Model 2.5C. It provides a brief functional description of the operating controls and connectors.

1-3. PURPOSE OF EQUIPMENT.

1-4. The frequency standard is designed to provide a highly accurate and stable standard for laboratory use, but is also suitable for use in timing and synchronous communications systems.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The frequency standard (figure 1-1) is 4.5 inches high, 4.5 inches wide, 14.25 inches deep, and weighs approximately 6.5 pounds. The rack mounted model (figure 1-2) is 19 inches wide and 5.25 inches high. It contains a crystal oscillator, an inner and outer oven, and associated frequency control and divider circuitry. Refer to table 1-1 for a functional description of the frequency standard controls, connectors, and indicators.

1-7. ELECTRICAL SPECIFICATIONS.

1-8. The electrical specifications of the frequency standard are listed in the following paragraphs.

1-9. OUTPUT REQUIREMENTS.

1-10.	Frequencies	100 kHz, 1 MHz, and 5 MHz simultaneously available. 5 MHz and 1 MHz outputs have spectral purity filters.
1-11.	Voltage	1 volt rms (-20%, +50%) for all three frequencies. Nonharmonically related outputs more than 80 dB down from rated output.

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Figure 1-1. Frequency Standard Models 2.5B and 2.5C.

Figure 1-2. Rack Mounted Frequency Standard With Power Supply.

Table 1-1
Frequency Standard Controls, Indicators, and Connectors

Name	Reference Designation	Function
Meter	M1	Provides readout for circuit monitor point selected by front panel selector.
Meter selector	S2	Selects internal circuit points for monitoring by front panel meter as follows: Position — Monitor Point 1 — DC input. (22-32 vdc on 50 volt scale.)

Table 1-1 (continued)

Name	Reference Designation	Function	
Meter selector	S2	Position	Monitor Point
		2	Voltage regulator output. (16-18 vdc on 25 volt scale.)
		3	AVC amplifier output voltage. (Arbitrary scale.)
		4	Inner oven temperature. (Reads 0 when temperature has stabilized.)
		5	Inner oven heater voltage. (25 volts dc full scale.)
		6	Outer oven heater voltage. (25 volts dc full scale.)
		7	5 MHz output signal. (1 volt rms on arbitrary scale.)
		8	1 MHz output signal. (1 volt rms on arbitrary scale.)
		9	100 KHz output signal. (1 volt rms on arbitrary scale.)
5 MHz connector	J2	Provides connection of 5 MHz output to external equipment.	

Table 1-1 (continued)

Name	Reference Designation	Function
1 MHz connector	J3	Provides connection of 1 MHz output to external equipment.
100 KHz	J4	Provides connection of 100 KHz output to external equipment.
START push-button	S3	Applies dc output of voltage regulator to oscillator in 5 MHz and 1 MHz dividers to start divider chain.
Frequency adjust control	C3	Adjusts crystal oscillator frequency 1 part in 10^7 over entire range in increments of 1 part in 10^{11} for each front panel minor dial division
Connector	J5	Provides connection of dc power to frequency standard and connection of frequency standard output signals to external equipment. (On rear of front panel.)
Connector	J6	Provides connection of external dc voltage to optional electrical frequency tuning circuit in frequency standard. (On rear of front panel.)

1-12. Frequency Stability

Short term stability (one second averaging) 1 part in 10^{11}.

Maximum $\Delta F/F$ for indicated change is as follows:

Change	$\Delta F/F$
27 vdc input changed ± 5 volts	<1 part in 10^{10}

	Change	ΔF/F
	50 ohm load changed ±20%	<1 part in 10^{10}
	25 °C ambient temperature changed from 35°C to 5°C.	<2 parts in 10^{10}

1-13. Aging Rate — For 24 hour period (after 90 days continuous operation): 1 part in 10^{10} (Model 2.5B); 5 parts in 10^{11} (Model 2.5C).

1-14. POWER REQUIREMENTS. — 27 (±5) volts dc, 0.33 amperes, less than 100 millivolts rms ripple (at 25 degrees C). When power is first applied, current will be 0.45 amperes maximum until oven heaters stabilize.

SECTION II

INSTALLATION

2-1. SCOPE OF SECTION.

2-2. This section provides instructions for installation of the frequency standard and connection of external power sources.

2-3. INSTALLATION.

2-4. Carefully unpack and examine the frequency standard for possible damage during shipment. Special attention should be given to areas where the outside shipping package was damaged.

CAUTION

To prevent over heating crystal oscillator, always provide adequate ventilation in mounting enclosure. Temperature in mounting enclosure should not exceed 35 degrees C.

2-5. RACK MOUNTING. The frequency standard can be factory mounted in a 19 inch rack panel either by itself, with another frequency standard, or with a Power Supply Model 5P. If the frequency standard is not factory mounted, it can be mounted in any suitable rack panel or cabinet. Refer to figure 2-1 for a template of the panel cutout required to mount the frequency standard. The frequency standard fastens to the rack panel with four 10-24 screws in its front panel.

2-6. If the frequency standard will be used as a mobile unit, the optional rear clamp (part number S-38181-1) should be used to support the rear of the frequency standard. The rear clamp must be supported with two side plates fastened between the panel and the rear clamp. The distance the rear clamp is positioned from the panel is not critical and can be changed to meet different mounting requirements. Figure 2-2 provides an outline of the frequency standard showing its center of gravity.

S-69011

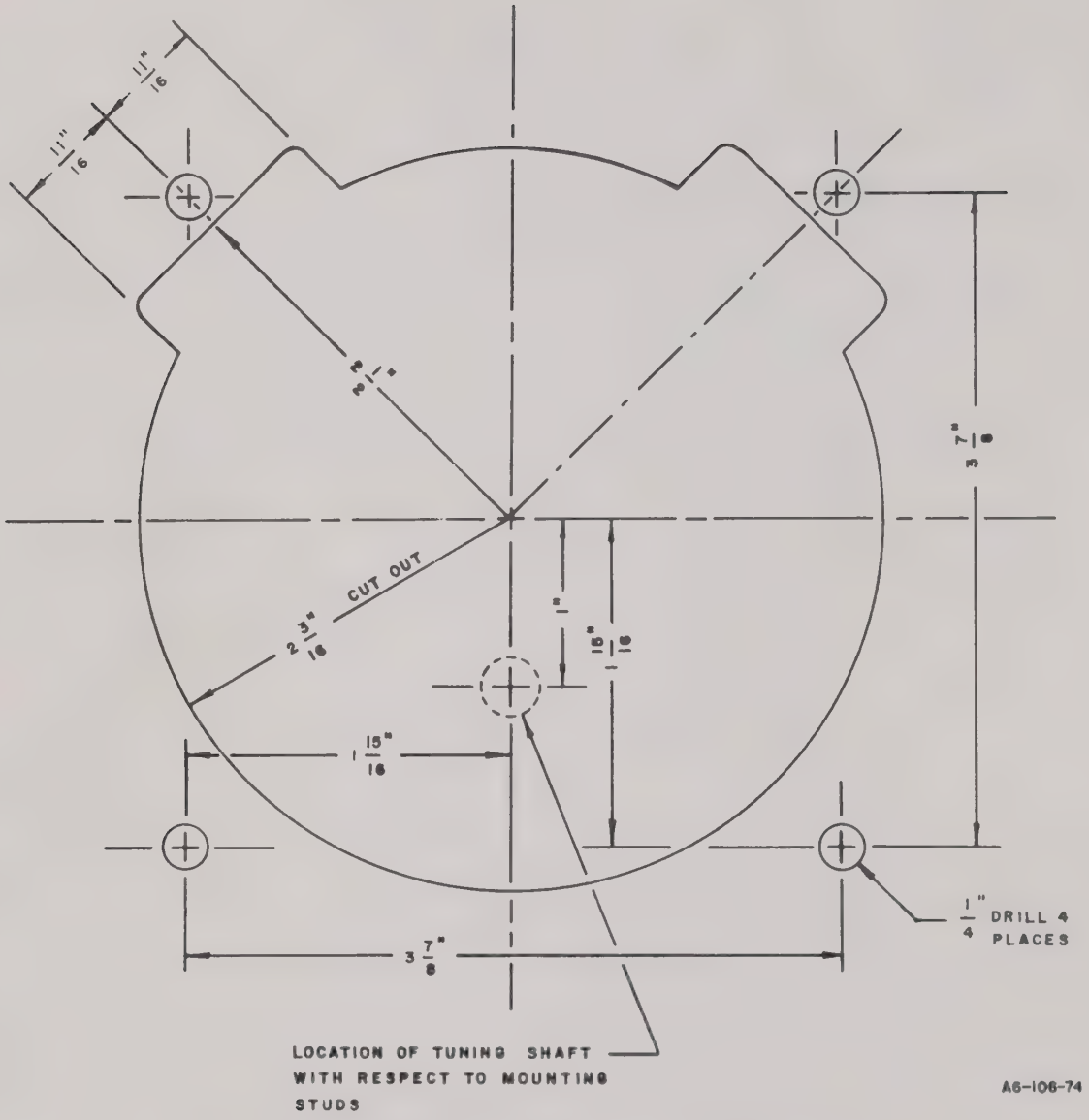

Figure 2-1. Rack Panel Mounting Template.

2-7. Refer to Appendix A Section II if optional power supply Model 5 P is being used and was not factory mounted with frequency standard.

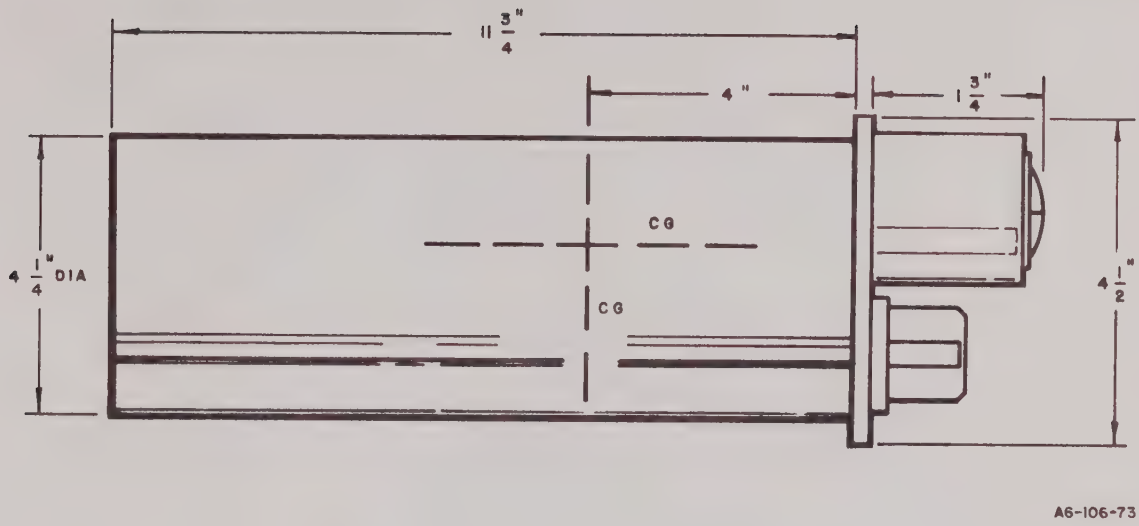

Figure 2-2. Frequency Standard Center of Gravity.

2-8. ELECTRICAL TUNING CONNECTIONS. When the frequency standard is equipped with the optional electrical tuning circuit, it is shipped with a 4 volt mercury battery across pins A and B on connector J6. If the electrical tuning option will not be connected, the battery should remain connected. Without this reference voltage, the frequency standard output frequency will be unstable.

2-9. When the external electrical tuning circuitry is ready to be connected, disconnect the 4 volt mercury battery and connect the electrical tuning equipment to the same pins on connector J6.

2-10. POWER CONNECTIONS. The power supply Model 5P, when factory mounted with the frequency standard, should be already connected to the frequency standard. Check that power supply cable is securely connected to connector J5 on rear of frequency standard front panel.

2-11. Any commercial dc power supply meeting the requirements specified in paragraph 1-14, can be used if the power supply Model 5P is not used. The commercial power supply output must be fused with a 1 ampere, fast acting fuse. Connect the commercial power supply to the frequency standard as follows:

a. Connect power supply positive terminal to pin B on connector J5 on rear of frequency standard front panel.

b. Connect power supply negative terminal to pin A on connector J5.

c. Connect all shields to chassis ground in the frequency standard through pin C on connector J5.

NOTE

The frequency standard does not have an internal ground for the power supply; therefore either lead may be grounded. Once a ground is selected it must be used consistently for all interconnections.

SECTION III
OPERATION

3-1. SCOPE OF SECTION.

3-2. This section provides detailed procedures for operation of the frequency standard.

3-3. EQUIPMENT TURN ON.

3-4. Turn on frequency standard and power supply as follows:

CAUTION

If optional power supply Model 5P is being used with the frequency standard, do not attempt to operate power supply before reading Operation and Service Manual supplied in Appendix A of this manual.

a. Connect power supply to facility power and set POWER switch on. If facility power is not available, set POWER switch on and press START pushbutton on power supply.

b. Press START pushbutton on frequency standard to start divider chain.

c. Allow frequency standard to warmup for 48 hours.

d. Set meter selector to position 4 to monitor inner oven temperature. The temperature is stabilized when meter indicates zero. Meter indicates low

d. (cont'd) temperature deviation from nominal of approximately 1 degree C per major division. If meter indication is below zero, temperature is high.

NOTE

Meter selector should remain in position 4 during normal operation. Do not leave selector in position 3. With meter selector in position 3, there will be a slight frequency shift in frequency standard output.

3-5. ELECTRICAL TUNING OPERATION.

3-6. If the frequency standard is equipped with optional electrical tuning, its output frequency can be changed using an external, variable dc source. The range of frequency change is 1 part in 10^8 when the external voltage is changed from 1 to 7 volts. The change sensitivity is approximately 1 part in 10^9 per volt at 4 volts.

3-7. The frequency standard is now ready for use.

SECTION IV

THEORY OF OPERATION

4-1. SCOPE OF SECTION.

4-2. This section provides a general description of the overall operation of the frequency standard and detailed analysis of its individual circuits. This analysis is supported by block diagrams and references to the schematic diagram as required.

4-3. FUNCTIONAL ANALYSIS.

4-4 The frequency standard can be divided into three main operational sections; the dc power regulating section, the frequency control section, and the temperature control section. Refer to figure 4-1 for a functional block diagram and to figure 7-1 for a schematic diagram of the frequency standard.

4-5. DC POWER REGULATING SECTION. The dc power regulating section consists of a passive inductive-capacitive (LC) filter network and a voltage regulator. The filter network filters the dc input voltage from the power supply and the voltage regulator stablizes the filter output voltage, which can vary from 22 to 32 volts, at 16.5 volts. The voltage regulator output is used by all circuits except the outer oven heater and output amplifier.

4-6. FREQUENCY CONTROL SECTION. The frequency control section consists of a 2.5 MHz crystal and oscillator circuit, an automatic voltage control (AVC) amplifier, a frequency doubler, three frequency dividers, and an amplifier for each of the three frequency outputs.

4-7. The crystal drives the oscillator at a frequency of 2.5 MHz, which is the fifth overtone of the fundemental crystal frequency. The oscillator output is amplified and controlled by the AVC amplifier. When the oscillator is first energized, it has a very low output amplitude. As it increases and becomes sufficiently great, the oscillator receives dc feedback from the

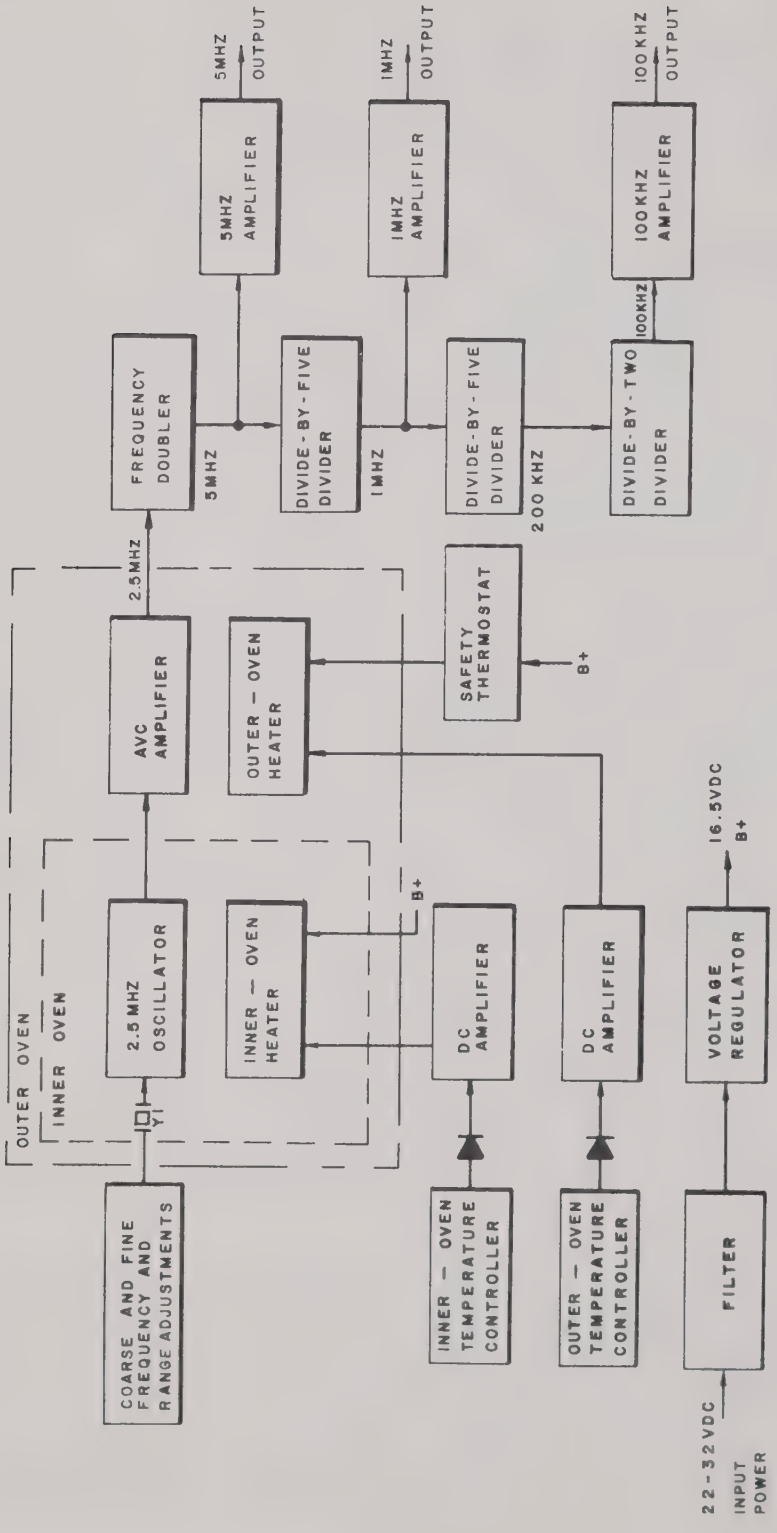

Figure 4-1. Frequency Standard Functional Block Diagram.

the AVC amplifier. This dc feedback decreases the oscillator output amplitude, which in turn reduces the dc feedback. When this output reaches equilibrium, the crystal power is stablized at approximately 1/4 of a microwatt. The AVC amplifier output is converted to a 5 mHz signal by the frequency doubler. This signal is sent to a divide-by five frequency divider and to a 5 MHz amplifier for use as the 5 MHz output. The frequency divider has a 1 MHz output. This output is sent to another divide-by-five frequency divider and to a 1 MHz amplifier for use as the 1 MHz output. This frequency divider has a 200 kHz output. Its output is sent to a divide-by-two frequency divider, which has a 100 kHz output. This output is sent to a 100 kHz amplifier for use as the 100 kHz output.

4-8. TEMPERATURE CONTROL SECTION. The temperature control section consists of an inner oven, which contains the crystal and the oscillator; the outer oven, which contains the inner oven, the inner oven temperature controller, and the AVC amplifier; and the two associated temperature control circuits.

4-9. The outer oven temperature controller is a two stage amplifier with an intermediate buffer stage. The last stage oscillates at 25 kHz. The amplifier output is coupled to a resistor-thermistor bridge through a transformer. The bridge output is connected to the amplifier input to provide positive feedback when the oven temperature is low. This causes the last stage of the amplifier to oscillate. This 25 kHz signal is rectified and doubled by a two stage dc amplifier and heats the heater winding wound around the outer oven. As the oven heats the bridge approaches a balance point, reducing the amount of positive feedback to the amplifier. This reduces the oscillation amplitude of the amplifier, reducing the dc heater voltage. This circuit reaches an equilibrium when power supplied to the oven equals the amount of power required to maintain a desired temperature. The stability of the outer oven is better than one degree C.

4-10. The inner oven controller is identical to the outer oven circuit except for component values and power dissapated The inner oven decreases the temperature variations of the outer oven by a factor of 600 or 1/600 degree C. The inner oven operates at the crystal turning point, or minimum point on the frequency-temperature characteristic curve. This means temperature variations in the crystal cause a minimum amount of frequency change.

4-11. DETAILED THEORY OF OPERATION .

4-12. The frequency standard contains a 2.5 MHz crystal, an oscillator, an AVC amplifier, a frequency doubler, two divide-by-five dividers, a divide-by-two divider, a 5 MHz output amplifier, a 1 MHz output amplifier, a 100 kHz output amplifier, two oven temperature controllers, and a dc voltage regulator and filter.

4-13. 2.5 MHZ OSCILLATOR. The 2.5 MHz oscillator is a modified Pierce type oscillator with the crystal connected between the base of transistor Q1 and ground through a frequency setting network. The frequency setting network consists of coarse frequency adjusting capacitor C2 in series with inductor L1, which is in series with the front panel fine frequency adjusting capacitor C3. Inductor L1, in series with the internal inductance of the crystal, sets the crystal to the desired frequency. The oscillator output is coupled through the tapped winding of toroid transformer T1 to the 2.5 MHz AVC amplifier. Transformer T1 has an output of 0.008 volts rms, this provides 1.1 volts dc feedback at the base of transister Q1 when the oscillator is stabilized. It also rejects the fundamental and third overtone frequencies of the crystal oscillator. Ferrite bead, T20, damps out high frequency oscillation between 3 and 500 MHz.

4-14. AVC AMPLIFIER. The AVC amplifier maintains low crystal output power for more efficient operation. The oscillator output is amplified by the two stage amplifier consisting of transistors Q2 and Q4. Transistor Q3 is an intermediate buffer stage.

4-15. When the crystal oscillator is first energized, the oscillation amplitude is very low. As the oscillation amplitude increases, diodes CR2 and CR3 begin to rectify. The dc output from the diodes feeds back to the base of transistor Q1, decreasing its base current. This decreases the transconductance of transistor Q1, decreasing its oscillation amplitude, which in turn decreases the dc feedback from the diodes. When it reaches an equilibrium, the oscillation amplitude produces just enough feedback to maintain correct crystal power, which is approximately one quarter microwatt. The 2.5 MHz output of the AVC amplifier is coupled through transformer T2 to the frequency doubler circuit.

4-16. FREQUENCY DOUBLER. The frequency doubler changes the output of the AVC amplifier from 2.5 MHz to 5 MHz. The secondary of transformer T2 is center tapped to provide two signals of opposite phase. One half of transformer T2 drives transistor Q18; the other half drives transistor Q18A. Since these two transistors conduct alternately, the frequency doubler output is a 5 MHz signal. This signal is coupled through transformer T5, which is tuned to 5 MHz, to the first frequency divider and to the 5 MHz amplifier as a frequency standard output signal.

4-17. FREQUENCY DIVIDER. The frequency standard contains three series connected frequency dividers. The first in the series divides the 5 MHz signal down to 1 MHz, the second divides the 1 MHz signal down to 200 kHz, and the third divides the 200 kHz signal down to 100 kHz. The first two dividers (divide-by-five dividers) are functionally the same, but operate at different frequencies.

4-18. Divide-By-Five Divider. The divider consists of three parts; a divider starter, a 1 MHz-to-4 MHz multiplier, and a mixer. Refer to figure 4-3 for a functional block diagram of the divide-by-five divider.

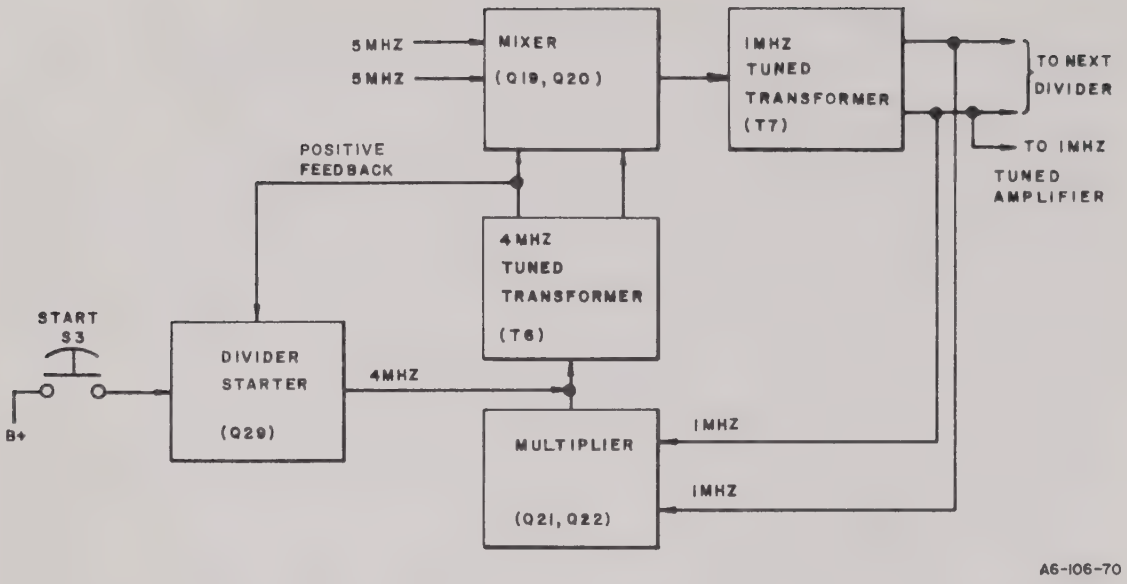

Figure 4-2. Divide-By-Five Divider Functional Block Diagram.

4-19. When the frequency standard is first installed, or after it has been turned off for any reason, the START pushbutton on the front panel must be pressed to start the divider. When this pushbutton is pressed, a dc voltage from the line filter is sent to the divider starter, transistor Q29. Transistor Q29 begins to oscillate at 4 MHz since its output is connected to the 4 MHz tank circuit, consisting of tuned transformer T6 and capacitor C42. Transistor Q29 receives feedback from the secondary of transformer T6 to sustain its oscillation. The center tapped secondary of transformer T6 is connected to the mixer to provide its second input. One half of the secondary is connected to transistor Q19; the other half to transistor Q20. The mixer combines the 5 MHz input signal, from tuned transformer T5, with the 4 MHz signal, and has an output equal to the difference between the two frequencies, or 1 MHz. The 5 MH_3 signal is applied to the bases of transistors Q19 and Q20, the

4 MHz signal to the emitters, and the 1 MHz output is on the collectors. This output signal is coupled through tuned transformer T7 which filters out unwanted frequencies produced by the mixer. The two output signals from the center tapped secondary of transformer T7 are sent back to the multiplier, which multiplies the signals to a single 4 MHz signal. When the START pushbutton is released, transistor Q29 stops oscillating. The multiplier supplies the 4 mHz signal required by the mixer. The divide-by-five divider now operates as a regenerative divider. The center tapped secondary of transformer T7 is also connected to the next divide-by-five divider and to the 1 MHz tuned amplifier.

4-20. The other divide-by-five divider divides the 1 MHz signal down to 200 kHz using a divider starter and multiplier that operate at 800 kHz. The 200 kHz signal is coupled through tuned transformer T9 to the divide-by-two divider.

4-21. Divide-By-Two Divider. The divide-by-two divider is self starting and converts the 200 kHz signal to a 100 kHz signal. The divider is a mixer consisting of transistors Q27 and Q28. The 100 kHz output of the center tapped secondary of transformer T10 is returned to transistors Q27 and Q28 where it mixes with the 200 kHz signal to provide a stable output equal to the difference between the two frequencies, or 100 kHz. This signal is sent to the 100 kHz tuned amplifier.

4-22. TUNED AMPLIFIER. The frequency standard has three tuned amplifiers; one for each of the three output frequencies of 5 MHz, 1 MHz, and 100 kHz. The three amplifiers are functionally the same. The 5 MHz and 1 MHz amplifiers each have a crystal filter in the input circuit, Y2 and Y3 respectively, to improve the spectral purity of the signals.

4-23. The amplifier is a single stage, common emitter configuration with a tuned output circuit. It produces an output of 1 volt rms into a 50 ohm load.

4-24. DC VOLTAGE REGULATOR AND FILTER. The line filter; consisting of inductors L2, L3, L4, and L5 and capacitors C71, C72, C73, and C74; removes high frequency voltages from the dc input that would interfere with the operation of the frequency standard. It also helps prevent radio frequency (rf) radiation of the signal frequencies in the frequency standard. Diode CR15, in the positive dc input line to the filter, protects against polarity reversal of the dc input. The filter output is used to start the divider chain and is sent to the voltage regulator.

4-25. The voltage regulator; consisting of transistors Q15, Q16, and Q17; regulates the input voltage, which can vary from 22 to 32 volts, to 16.5 ($\pm$0.1) volts for use by all the frequency control circuits and the inner oven heater. (The outer oven heater and output amplifier uses unregulated 27 volt dc power.)

4-26. The output of the line filter is applied to the collector of transistor Q15 as the voltage regulator input. The voltage regulator output at the emitter of transistor Q15 is controlled by the dc current from transistor Q16. Transistor Q16 couples the dc voltage from transistor Q17, which compares part of the voltage regulator output to the dc voltage across diode CR8 and has a dc output proportional to the difference between these two voltages. If the voltage regulator output is low, transistor Q17 starts to turn off, increasing the base current of transistor Q16. This increases the base current of transistor Q15. By increasing the base current of transistor Q15, the voltage drop across transistor Q15 decreases, which increases the output of the voltage regulator.

4-27. OVEN TEMPERATURE CONTROLLER. The temperature controllers for the inner and outer ovens provide a highly stablized thermal environment for the crystal, and its oscillator, located inside the inner oven. The inner and outer oven temperature controllers are functionally the same, therefore only the

detailed theory of operation for the inner oven will be presented in the following paragraph. Refer to figure 4-3 for a functional block diagram of the inner oven temperature controller.

4-28. The temperature controller consists of a two stage oscillator with an intermediate buffer stage, a resistor-thermistor bridge, and a two stage heater voltage amplifier. The three stage oscillator is made up of common emitter transistor Q5 direct coupled to emitter follower transistor Q6, which is direct coupled to common emitter transistor Q7. The output of transistor Q7 is connected to the primary winding of transformer T3. Both halves of the center tapped secondary winding of the transformer are connected to the bridge circuit consisting of potentiometer R23 and resistor R24, as one half of the bridge, and thermistor RT1, as the other half of the bridge. When the oven is below its operating temperature, the resistance of thermistor TR1 is higher than its normal value. This unbalances the bridge circuit, which is connected to transistor Q5 as the oscillator input, causing positive feedback. This causes the

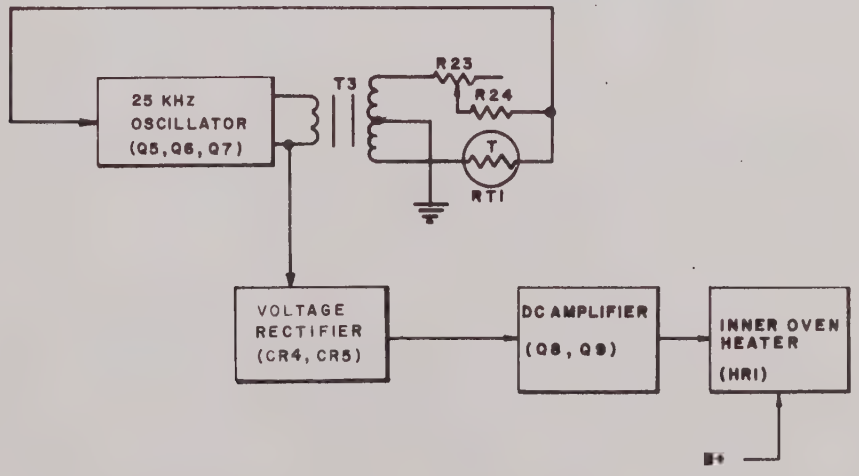

Figure 4-3. Inner Oven Temperature Controller Functional Block Diagram.

25 kHz oscillation amplitude to increase.

4-29. The oscillator output is coupled to the two stage dc amplifier, consisting of transistor Q8 and Q9 through diodes CR4 and CR5 which rectify the 25 kHz signal. The output of transistor Q9 is applied to the inner oven heater HR1. As the oven temperature increases, the resistance of thermistor RT1 decreases, causing the bridge circuit to approach a balance. This reduces the positive feedback, reducing the amplitude of the oscillator output, which reduces the heater current. The oven temperature reaches an equilibrium when the power supplied to the heater equals the amount of power required to maintain the desired temperature. Potentiometer R23 adjusts the feedback of the controller circuit which determines the temperature at which the oven operates.

SECTION V
MAINTENANCE

5-1. SCOPE OF SECTION.

5-2. This section provides a list of all special test equipment required, a table of common malfunctions and probable causes, and calibration procedures for adjusting the output frequency and for aligning the tuned transformers in the frequency standard.

5-3. TEST EQUIPMENT REQUIRED.

5-4. All special test equipment required to analyze malfunctions and perform required calibrations is as follows:

a. Primary frequency standard or VLF receiver (TRACOR Series 599).

b. Frequency difference meter (TRACOR Model 527A) or phase comparator (TRACOR Model 1LPD).

c. 4 volt rms, 5 MHz to 200 kHz source.

d. Oscilloscope or vacuum tube voltmeter with high impedance probe (15 pf or less).

e. 0-30 volt, 0.5 ampere dc power supply.

5-5. TROUBLE ANALYSIS.

5-6. The operator should become familiar with the operating instructions in section III and the theory of operation in section IV before performing a trouble analysis on the frequency standard. Table 5-1 lists the most common troubles and associated probable malfunctioning circuits.

5-7. CALIBRATION.

5-8. This paragraph provides procedures for adjustment of the frequency output and alignment of the tuned transformers of the frequency standard. Refer to the schematic diagram (figure 7-1) to aid in locating the components requiring adjustment. Figure 7-2 shows the location of the tuned transformers and frequency adjustment controls in the frequency standard.

Table 5-1
Common Troubles and Probable Malfunctioning Circuits

Trouble	Probable Malfunctioning Circuit
No frequency outputs present	Power supply fuse Voltage regulator AVC amplifier Frequency doubler
100 kHz output not present, but 5 MHz and 1 MHz outputs present	100 kHz amplifier Divide-by-two divider Second divide-by-five divider (1 MHz to 200 kHz)
100 kHz and 1 MHz outputs not present, but 5 MHz output present	Press START pushbutton First divide-by-five divider (5 MHz to 1 MHz)
1 MHz output not present, but 5 MHz and 100 kHz outputs present	1 MHz amplifier
5 MHz output not present, but 1 MHz and 100 kHz outputs present	5 MHz amplifier
All output frequencies off by small amount, but output voltages normal	Inner oven Frequency requires adjustment after long period of operation or storage
All output frequencies off by large amount, but output voltages normal	Outer oven

5-9. FREQUENCY ADJUSTMENT. Because of the aging rate of the crystal, the frequency change will require compensation using either the front panel fine adjustment or the internal coarse adjustment. Whenever a frequency adjustment is made, the frequency standard output must be compared to an external frequency reference. This can be done using either of the following methods:

a. The two signals can be compared using a phase comparator such as the TRACOR Model 1LPD.

b. The two signals can be compared using a frequency difference meter such as the TRACOR Model 527A.

5-10. Either one of the following references can be used as the external frequency reference:

a. Another frequency standard can be used as the external reference.

b. The signals broadcast by the National Bureau of Standards (NBS) stations WWVB (20 kHz) or WWVL (60 kHz) can be used as the external reference.

5-11. Another method that can be used, is comparing the NBS high frequency station WWV ground wave to the frequency standard output on a chart recorder as a beat frequency difference. However, this method requires at least 48 hours to check the frequency standard to an accuracy of 1 part in 10^{10}. These two signals can also be compared on the chart recorder using the "time ticks". This method requires several weeks to check the frequency standard to an accuracy of 1 part in 10^{10}, during which time crystal aging can be sufficient to prevent achieving this accuracy.

5-12. Fine Frequency Adjustment. Adjust the frequency standard output using the front panel control as follows:

a. Insure frequency standard has been operating for minimum of 48 hours before proceeding.

b. Set meter selector to position 4 to check that inner oven temperature has stabilized. Meter should indicate zero.

c. Connect frequency standard 5 MC connector, or pin D on dc power input connector, to frequency difference measuring instrument.

d. Connect primary frequency reference to frequency difference measuring instrument.

NOTE

Frequency standard output will change approximately 1 part in 10^{11} for each minor division front panel control is adjusted.

e. Determine amount of adjustment required using frequency difference measuring instrument.

f. Adjust front panel control for required frequency change. Clockwise adjustment increases frequency and counterclockwise adjustment decreases frequency.

g. Allow frequency standard to stabilize for several seconds, then determine if further adjustment is required using frequency difference measuring instrument.

h. Readjust front panel control as required. If front panel control reaches end of range before required frequency change can be made, an internal coarse frequency adjustment must be made.

5-13. Coarse Frequency Adjustment. Adjust the frequency standard output using the internal control as follows:

a. Remove frequency standard from mountings.

b. Remove outer cylindrical cover from frequency standard.

c. Set meter selector to position 4 to check that inner oven temperature has stabilized. Meter should indicate zero.

d. Set front panel fine adjustment control to 1300.

e. Adjust coarse frequency control, inside hole marked FREQUENCY on back of outer oven. Clockwise adjustment decreases frequency and counterclockwise adjustment increases frequency.

f. Allow frequency standard to stabilize for several seconds, then determine if further adjustment is required using frequency difference measuring instrument.

k. Readjust coarse adjustment control as required. If coarse adjustment control reaches end of range before required frequency change can be made, capacitor must be added in parallel with capacitor C1; otherwise, reassemble frequency standard.

5-14 Adding Capacitor. A capacitor will normally have to be added to the circuit after 10 to 15 years of operation. It is recommended that the frequency standard be returned to the factory for this change. The capacitor can be added without returning the frequency standard to the factory. Add the capacitor as follows:

a. Remove dc power from frequency standard.

b. Remove outer oven.

c. Remove inner oven end cover cap.

d. Add 20 to 30 picofarad Corning glass capacitor across capacitor C1. If Corning glass capacitor is not available, a high quality silvered mica capacitor may be used.

e. Replace inner oven end cover cap and outer oven.

f. Apply power to frequency standard and allow to stabilize for 48 hours.

g. Readjust frequency standard frequency in accordance with paragraph 5-13.

5-15. TUNED TRANSFORMER ALIGNMENT. The tuned transformers in the frequency standard will require retuning if the dividers or amplifiers are not functioning properly. This would normally be caused by component values shifting.

5-16. Retune the transformers as follows:

a. Remove all power from frequency standard.

b. Remove frequency standard from mountings.

c. Remove outer cylindrical cover from frequency standard.

NOTE

Apply all input signals through 15K source impedance. Make all voltage measurements between the 15K source impedance and the frequency standard. Tolerance on all frequency settings and measurements is 1 volt rms, $\pm$0.001%.

d. Apply 5 MHz signal to transformer T5 primary winding.

e. Adjust transformer T5 for maximum output at secondary winding.

f. Remove 5 MHz signal and apply 4 volt rms, 1 MHz signal to transformer T7 primary winding.

g. Adjust transformer T7 for maximum output at secondary winding.

h. Remove 1 MHz signal and apply 4 volt rms, 4 MHz signal to transformer T6 primary winding.

i. Adjust transformer T6 for maximum output at secondary winding.

j. Remove 4 MHz signal and apply 4 volt rms, 200 kHz signal to transformer T9 primary winding.

k. Adjust transformer T9 for maximum output at secondary winding.

l. Remove 200 kHz signal and apply 4 volt rms, 800 kHz signal to transformer T8 primary winding.

m. Adjust transformer T8 for maximum output at secondary winding.
n. Remove 800 kHz signal.
o. Connect dc power supply to connector J5 pin B(+) and pin A(-).
p. Set dc power supply to 26.5 volts.
q. Press START pushbutton.
r. Measure voltage at transistor Q18 collector. Voltage shall be 22 volts peak to peak (±5%).
s. Check that all three frequency outputs are present. If outputs are present, proceed to step t.
t. Press and hold START pushbutton while adjusting two tuned transformers on divider not operating. Adjust transformers until divider operation is stable at correct frequency when START pushbutton is released. Dividers should operate down to 12 volt dc input and restart at that input voltage.
u. Adjust transformer T10 for maximum output at secondary winding.
v. Adjust transformers T11, T12, and T13 for 1 volt rms, 5 MHz output into 50 ohms at 5 MHZ connector.
w. Adjust transformers T14, T15, and T16 for 1 volt rms, 1 MHz output into 50 ohms at 1 MHZ connector.
x. Adjust transformers T17, T18, and T19 for 1 volt rms, 100 kHz output into 50 ohms at 100 KHZ connector.
y. Reassemble frequency standard.
z. Allow frequency standard output to stabilize 48 hours before measuring output frequency.

5-17. Frequency standard is now ready for use.

SECTION VI

REPLACEABLE PARTS

6-1. SCOPE OF SECTION.

6-2. This section provides all necessary information for quick identification of replaceable parts for the frequency standard. The section contains a list of replaceable parts and a numeric list of federal supply codes for manufacturers.

6-3. LIST OF REPLACEABLE PARTS.

6-4. A list of replaceable parts for the frequency standard is presented in table 6-1. Information in the table includes the reference designation, part description, Sulzer Laboratories stock number, federal supply code for manufacturers (FSCM), and manufacturer part number, presented in that order.

6-5. REFERENCE DESIGNATION. The reference designation is an alpha-numeric identification assigned to each assembly and to electrical components within an assembly. Reference designations are obtained by referring to the schematic diagram (figure 7-1) or by markings on the assembly.

6-6. PART DESCRIPTION. All parts are described using the noun-modifier method. For example, a 2500 ohm variable resistor is described as: RES VAR 2X5 K. The "X" between the "2" and the "5" represents the decimal location.

6-7. SULZER LABORATORIES STOCK NUMBER. A Sulzer Laboratories stock number is assigned to replaceable parts in the frequency standard. Identical parts have identical stock numbers. Presently, only replaceable parts manufactured or assembled by Sulzer Laboratories have a stock number assigned to them.

6-8. FEDERAL SUPPLY CODE FOR MANUFACTURERS.

6-9. A list of manufacturers supplying parts for the frequency standard is provided in table 6-2. Information in the table includes the manufacturer federal supply code number, manufacturer's name, and manufacturer's address, presented in

that order. The manufacturers are listed in numerical order by federal supply code number.

6-10. To locate the manufacturer of a part, proceed as follows:

a. Obtain the manufacturer federal supply code number by referring to the List of Replaceable Parts (table 6-1).

b. Locate the federal supply code number in the appropriate column of the Federal Supply Code for Manufacturers (table 6-2).

6-11. ORDERING INFORMATION.

6-12. Address orders or inquiries to either an authorized Sulzer Laboratories Sales Representative or to:

Customer Service
Sulzer Laboratories Division,
TRACOR, Inc.
9610 Bellanca Avenue
Los Angeles, California 90045

6-13. To insure prompt service, orders must include the following information:

a. Name, model, and serial number of the instrument.

b. Reference designation, if applicable.

c. Sulzer Laboratories stock number, if one is assigned.

d. Full description of the part.

6-14. Item a. is located on the instrument; items b., c., and d. are found in the List of Replaceable Parts (table 6-1).

6-15. The part numbers shown will change occasionally as manufacturers' items are reevaluated or as improved components become available. The component shipped will be the component used in production at the time the order is received, and will be equivalent to the component it replaces in both dimensions and performance.

6-16. The minimum billing on any order is $15.00, with a standard delivery of 30 days. All prices are FOB Los Angeles, California, and are subject to change without notice.

Table 6-1

List of Replaceable Parts

REF DES	DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
C 1	CAP FXD GLASS SLCD		76299	CYFM10C
C 2	CAP VAR GLASS 28 PFD		73899	MC 603
C 3	CAP VAR GLASS 18 PFD	S-28010	23732	S-28010
C 4	CAP FXD GLASS SLCD		76299	CYFM10C
C 5	CAP VAR GLASS 28 PFD		73899	MC603
C 6	CAP FXD GLASS 2200 PFD		76299	CYFM20C222K
C 7	CAP FXD GLASS 680 PFD		76299	CYFM15C681K
C 8	CAP FXD CER X02 MFD		00656	MC80V203AM
C 9	CAP FXD CER X005 MFD		00656	MC80V502AM
C 10	CAP FXD CER X005 MFD		00656	MC80V502AM
C 11	CAP FXD MICA X001 MFD		84171	DM-15E-102-J
C 12	CAP FXD CER X005 MFD		00656	MC80V502AM
C 13	CAP FXD CER X005 MFD		00656	MC80V502AM
C 14	CAP FXD CER X005 MFD		00656	MC80V502AM
C 15	CAP FXD CER X005 MFD		00656	MC80V502AM
C 16	CAP FXD MICA X001 MFD		84171	DM-15E-102-J
C 17	CAP FXD MICA 470 MFD		84171	DM-15E-471-J
C 18	CAP FXD CER X005 MFD		00656	MC80V502AM
C 19	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 20	CAP FXD CER X005 MFD		00656	MC80V502AM
C 21	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 22	CAP FXD CER X02 MFD		00656	MC80V203AM
C 23	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 24	CAP FXD CER X02 MFD		00656	MC80V203AM
C 25	CAP SOLID TA 3X3 MFD		56289	150D335X0010A2
C 26	CAP FXD CER X02 MFD		00656	MC80V203AM
C 27	CAP SOLID TA 3X3 MFD		56289	150D335X0010A2
C 28	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 29	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 30	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 31	CAP FXD CER X02 MFD		00656	MC80V203AM
C 32	CAP FXD CER X02 MFD		00656	MC80V203AM
C 33	CAP SOLID TA 3X3 MFD		56289	150D335X0010A2
C 34	CAP SOLID TA 3X3 MFD		56289	150D335X0010A2
C 35	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 36	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 37	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 38	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 39	CAP FXD CER X01 MFD		00656	MC80V103AM
C 40	CAP FXD CER 180 PFD		00656	DM-10-181-J
C 41	CAP FXD CER X01 MFD		00656	MC80V103AM
C 42	CAP FXD MICA 220 PFD		84171	DM-10E-221J
C 43	CAP FXD MICA 330 PFD		84171	DM-15E-331-J
C 44	CAP FXD CER 220 PFD		00656	MC80V221AM
C 45	CAP FXD CER 220 PFD		00656	MC80V221AM
C 46	CAP FXD MICA 330 PFD		84171	DM-15E-331-J
C 47	CAP FXD MICA X0015 MFD		84171	DM-15E-152-J
C 48	CAP FXD CER X001 MFD		00656	MC80V102AM
C 49	CAP FXD CER X001 MFD		00656	MC80V102AM
C 50	CAP FXD MICA 5600 PFD		84171	DM-20E562J
C 51	CAP FXD CER 220 PFD		00656	MC80V221AM
C 52	CAP FXD CER X001 MFD		00656	MC80V102AM
C 53	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 54	CAP FXD CER X02 MFD		00656	MC80V203AM
C 55	CAP FXD CER X01 MFD		00656	MC80V103AM
C 56	CAP FXD MICA 100 PFD		84171	DM-15E-101-J
C 57	CAP FXD CER X01 MFD		00656	MC80V103AM
C 58	CAP FXD CER X02 MFD		00656	MC80V203AM
C 59	CAP FXD MICA 220 PFD		84171	DM-15E-221-J
C 60	CAP FXD MICA 220 PFD		84171	DM-15E-221-J
C 60A	CAP FXD CER X01 MFD		00656	MC-80V103AM
C 61	CAP FXD MICA 1000 PFD		84171	DM-15E-102-J
C 62	CAP FXD CER X02 MFD		00656	MC80V203AM
C 63	CAP FXD CER X02 MFD		00656	MC80V203AM
C 64	CAP FXD MICA 1000 PFD		84171	DM-15E-102-J
C 65	CAP FXD MICA 1000 PFD		84171	DM-15E-102-J
C 66	CAP FXD MICA X0082 MFD		84171	DM-19E-822-J
C 66A	CAP FXD MICA SLCD		84171	DM-15-102-J
C 67	CAP SOLID TA 1X0 MFD		56289	150D105X0035A2
C 68	CAP FXD CER X02 MFD		00656	MC80V203AM
C 69	CAP FXD MICA X0082 MFD		84171	DM-19E-822-J

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Table 6-1 (Continued)

REF DES	DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
C 70	CAP FXD MICA X0082 MFD		84171	DM-19E-882-J
C 71	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 72	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 73	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 74	CAP SOLID TA 4X7 MFD		56289	150D475X0035B2
C 75	CAP FXD CER X001 MFD		00656	MC80V102AM
C 76	CAP FXD CER X001 MFD		00656	MC80V102AM
C 77	CAP FXD CER X005 MFD		00656	MC80V502AM
C 78	CAP FXD CER X005 MFD		00656	MC80V502AM
C 79	CAP FXD CER X005 MFD		00656	MC80V502AM
C 80	CAP FXD CER 1800 PFD		71590	FT1800
C 81	CAP FXD CER 1800 PFD		71590	FT1800
E 1	KNOB		83330	2223
E 2	DIAL		02111	25-4-13
J 1	CONNECTOR JACK		81312	SRE7SJ
J 2	CONNECTOR BNC		71468	UG1094U
J 3	CONNECTOR BNC		71468	UG1094U
J 4	CONNECTOR BNC		71468	UG1094U
J 5	CONNECTOR JACK		81312	SRE7PJ
J 6	CONNECTOR JACK		81312	SRE7PJ
L 1	INDUCTOR SLCD	2.5-L1	23732	2.5-L1
L 2	*INDUCTOR	S-18060	23732	S-18060
L 3	*INDUCTOR	S-18060	23732	S-18060
L 4	+INDUCTOR	S-18060	23732	S-18060
L 5	+INDUCTOR	S-18060	23732	S-18060
M 1	METER		38315	0-100 DC UA
P 1	CONNECTOR PLUG		81312	SRE7PJ
P 2	CONNECTOR PLUG		81312	SRE7SJ
P 3	CONNECTOR PLUG		81312	SRE7SJ
Q 1	TSTR NPN 40235		02735	40235
Q 2	TSTR NPN 2N2221		01295	2N2221
Q 3	TSTR NPN 2N2221		01295	2N2221
Q 4	TSTR NPN 2N2221		01295	2N2221
Q 5	TSTR NPN 2N697		01295	2N697
Q 6	TSTR NPN 2N697		01295	2N697
Q 7	TSTR NPN 2N697		01295	2N697
Q 8	TSTR NPN 2N697		01295	2N697
Q 9	TSTR NPN 2N697		01295	2N697
Q 10	TSTR NPN 2N697		01295	2N697
Q 11	TSTR NPN 2N697		01295	2N697
Q 12	TSTR NPN 2N697		01295	2N697
Q 13	TSTR NPN 2N697		01295	2N697
Q 14	TSTR NPN 2N1701		02735	2N1701
Q 15	TSTR NPN 2N1701		02735	2N1701
Q 16	TSTR NPN 2N697		01295	2N697
Q 17	TSTR NPN 2N697		01295	2N697
Q 18	TSTR NPN 2N2221		01295	2N2221
Q 18A	TSTR NPN 2N2221		01295	2N2221
Q 19	TSTR NPN 2N2221		01295	2N2221
Q 20	TSTR NPN 2N2221		01295	2N2221
Q 21	TSTR NPN 2N2221		01295	2N2221
Q 22	TSTR NPN 2N2221		01295	2N2221
Q 23	TSTR NPN 2N2221		01295	2N2221
Q 24	TSTR NPN 2N2221		01295	2N2221
Q 25	TSTR NPN 2N2221		01295	2N2221
Q 26	TSTR NPN 2N2221		01295	2N2221
Q 27	TSTR NPN 2N2221		01295	2N2221
Q 28	TSTR NPN 2N2221		01295	2N2221
Q 29	TSTR NPN 2N2221		01295	2N2221
Q 29A	TSTR NPN 2N2221		01295	2N2221
Q 30	TSTR NPN 2N2221		01295	2N2221
Q 31	TSTR NPN 2N2221		01295	2N2221
Q 32	TSTR NPN 2N2221		01295	2N2221
R 1	RES FXD COMP 1X0 K		01121	RC07
R 2	RES FXD COMP 4X7 K		01121	RC07
R 3	RES FXD COMP 1X0 K		01121	RC07
R 4	RES FXD COMP 1X0 K		01121	RC07
R 5	RES FXD COMP 4X7 K		01121	RC07
R 6	RES FXD COMP 1X0 K		01121	RC07
R 7	RES FXD COMP 1X5 K		01121	RC07
R 8	RES FXD COMP 2X2 K		01121	RC07
	*L2, L3 WOUND ON ONE CORE			
	+L4, L5 WOUND ON ONE CORE			

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Table 6-1 (Continued)

REF DES	DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
R 9	RES FXD COMP 10 K		01121	RC07
R 10	RES FXD COMP 47 OHM		01121	RC07
R 11	RES FXD COMP 4X7 K		01121	RC07
R 12	RES FXD COMP 1X0 K		01121	RC07
R 13	RES FXD COMP 1X0 K		01121	RC07
R 14	RES FXD COMP 470 OHM		01121	RC07
R 15	RES FXD COMP 10 K		01121	RC07
R 16	RES FXD COMP 47 OHM		01121	RC07
R 17	RES FXD COMP 10 K		01121	RC07
R 18	RES FXD COMP 6X8 K		01121	RC07
R 19	RES FXD COMP 10 K		01121	RC07
R 20	RES FXD COMP 470 OHM		01121	RC07
R 20A	RES FXD COMP 100 OHM		01121	RC07
R 21	RES FXD COMP 1X0 K		01121	RC07
R 22	RES FXD COMP 15 K		01121	RC07
R 23	RES VAR 500 OHM		80294	224L-1-501
R 24	RES FXD DEP CARB SLCD		01295	CR 1/8
R 25	RES FXD COMP 100 K		01121	RC07
R 26	RES FXD COMP 1X0 K		01121	RC07
R 26A	RES FXD COMP SLCD		01121	RC07
R 27	RES FXD COMP 47 OHM		01121	RC07
R 28	RES FXD COMP 10 K		01121	RC07
R 29	RES FXD COMP 6X8 K		01121	RC07
R 30	RES FXD COMP 10 K		01121	RC07
R 31	RES FXD COMP 470 OHM		01121	RC07
R 31A	RES FXD COMP 100 OHM		01121	RC07
R 32	RES FXD COMP 1X0 K		01121	RC07
R 33	RES FXD COMP 22 K		01121	RC07
R 34	RES VAR 2X0 K		80294	224L-1-202
R 34A	RES FXD DEP CARB SLCD		01295	CR 1/8
R 35	RES FXD COMP 100 K		01121	RC07
R 36	RES FXD COMP 1X0 K		01121	RC07
R 37	RES FXD COMP 47 OHM		01121	RC07
R 38	RES FXD COMP 3X3 K		01121	RC07
R 39	RES FXD COMP 4X7 K		01121	RC07
R 40	RES FXD COMP 470 OHM		01121	RC07
R 41	RES FXD COMP 2X2 K		01121	RC07
R 42	RES FXD COMP 10 K		01121	RC07
R 43	RES FXD COMP 22X1 K		01295	CR 1/8
R 44	RES FXD COMP 22X1 K		01295	CR 1/8
R 45	RES VAR 2X0 K		80294	224L-1-202
R 45A	RES FXD DEP CARB SLCD		01295	CR 1/8
R 46	RES FXD COMP 4X7 K		01121	RC07
R 47	RES FXD COMP 22 K		01121	RC07
R 47A	RES FXD COMP 10 K		01121	RC07
R 48	RES FXD COMP 220 OHM		01121	RC07
R 49	RES FXD COMP 220 OHM		01121	RC07
R 50	RES FXD COMP 470 OHM		01121	RC07
R 51	RES FXD COMP 470 OHM		01121	RC07
R 52	RES FXD COMP 100 OHM		01121	RC07
R 53	RES FXD COMP 470 OHM		01121	RC07
R 54	RES FXD COMP 470 OHM		01121	RC07
R 55	RES FXD COMP 10 K		01121	RC07
R 56	RES FXD COMP 10 K		01121	RC07
R 57	RES FXD COMP 1X0 K		01121	RC07
R 58	RES FXD COMP 1X0 K		01121	RC07
R 59	RES FXD COMP 220 OHM		01121	RC07
R 60	RES FXD COMP 470 OHM		01121	RC07
R 61	RES FXD COMP 470 OHM		01121	RC07
R 62	RES FXD COMP 10 K		01121	RC07
R 63	RES FXD COMP 10 K		01121	RC07
R 64	NOT USED			
R 64A	RES FXD COMP 220 OHM		01121	RC07
R 64B	RES FXD COMP 220 OHM		01121	RC07
R 65	RES FXD COMP 470 OHM		01121	RC07
R 66	NOT USED			
R 67	RES FXD COMP 10 K		01121	RC07
R 68	RES FXD COMP 2X2 K		01121	RC07
R 68A	RES FXD COMP SLCD		01121	RC07
R 69	RES FXD COMP 15 K		01121	RC07
R 70	RES FXD COMP 100 OHM		01121	RC07
R 71	RES FXD COMP 220 OHM		01121	RC07
R 72	RES FXD COMP 33 K		01121	RC07
R 73	RES FXD COMP 470 OHM		01121	RC07
R 74	RES FXD COMP 2X2 K		01121	RC07
R 74A	RES FXD COMP SLCD		01121	RC07

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Table 6-1 (Continued)

REF DES	DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
R 75	RES FXD COMP 15 K		01121	RC07
R 76	RES FXD COMP 100 OHM		01121	RC07
R 77	RES FXD COMP 150 OHM		01121	RC07
R 78	RES FXD COMP 33 K		01121	RC07
R 79	RES FXD COMP 470 OHM		01121	RC07
R 80	RES FXD COMP 2X2 K		01121	RC07
R 81	RES FXD COMP 15 K		01121	RC07
R 82	RES FXD COMP 100 OHM		01121	RC07
R 83	RES FXD COMP 150 OHM		01121	RC07
R 84	RES FXD COMP 33 K		01121	RC07
R 85	RES FXD COMP 470 OHM		01121	RC07
R 86	RES FXD DEP CARB 150 K		01295	CR 1/8
R 87	RES FXD DEP CARB 249 K		01295	CR 1/8
R 88	RES FXD DEP CARB 499 K		01295	CR 1/8
R 89	RES FXD DEP CARB 249 K		01295	CR 1/8
R 90	RES FXD COMP 470 OHM		01121	RC07
R 91	RES FXD COMP 100 K		01121	RC07
R 92	RES FXD COMP 100 K		01121	RC07
R 93	RES FXD COMP 100 K		01121	RC07
R 94	RES FXD COMP 100 K		01121	RC07
R 95	RES FXD COMP 100 K		01121	RC07
R 96	RES FXD COMP 100 K		01121	RC07
R 97	RES FXD COMP 470 K		01121	RC07
R 98	RES FXD COMP 220 OHM		01121	RC07
R 99	RES FXD COMP 220 OHM		01121	RC07
R 100	RES FXD COMP 100 OHM		01121	RC07
R 101	RES FXD COMP 470 K		01121	RC07
R 102	RES FXD COMP 220 OHM		01121	RC07
R 103	RES FXD COMP 220 OHM		01121	RC07
R 104	RES FXD COMP 100 OHM		01121	RC07
S 1	SWITCH THERMOSTAT		80640	MX-300
S 2	SWITCH ROTARY		81073	24002-9
S 3	SWITCH PUSHBUTTON		81073	30-1
T 1	XFMR	S-28072	23732	S-28072
T 2	XFMR	S-28063	23732	S-28063
T 3	XFMR	S-38062C	23732	S-38062C
T 4	XFMR	S-38062C	23732	S-38062C
T 5	XFMR VAR TUNE	7-30	23732	7-30
T 6	XFMR VAR TUNE	7-40	23732	7-40
T 7	XFMR VAR TUNE	7-110	23732	7-110
T 8	XFMR VAR TUNE	7-140	23732	7-140
T 9	XFMR VAR TUNE	7-220	23732	7-220
T 10	XFMR VAR TUNE	7-220	23732	7-220
T 11	XFMR VAR TUNE	7-30	23732	7-30
T 12	XFMR VAR TUNE	7-30	23732	7-30
T 13	XFMR VAR TUNE	7-30	23732	7-30
T 14	XFMR VAR TUNE	7-60	23732	7-60
T 15	XFMR VAR TUNE	7-60	23732	7-60
T 16	XFMR VAR TUNE	7-60	23732	7-60
T 17	XFMR VAR TUNE	7-180	23732	7-180
T 18	XFMR VAR TUNE	7-180	23732	7-180
T 19	XFMR VAR TUNE	7-180	23732	7-180
T 20	FERRITE BEAD		02114	56-590-65-3B
Y 1	XTAL 2.5 MHZ		71034	BG11AH-5
Y 2	XTAL FILTER 5 MHZ		06961	4051122 5MHZ
Y 3	XTAL FILTER 1 MHZ		06961	4051122 1MHZ
CR 1	DIODE 1N960B		01295	1N662
CR 2	DIODE 1N662		01295	1N662
CR 3	DIODE 1N662		01295	1N662
CR 4	DIODE 1N662		01295	1N662
CR 5	DIODE 1N662		01295	1N662
CR 6	DIODE 1N662		01295	1N662
CR 7	DIODE 1N662		01295	1N662
CR 8	DIODE 1N757A		04713	1N757A
CR 9	VARICAP		01281	V7E
CR 10	NOT USED			
CR 11	NOT USED			
CR 12	DIODE 1N662		01295	1N662
CR 13	DIODE 1N662		01295	1N662
CR 14	DIODE 1N662		01295	1N662
CR 15	DIODE 1N4384		01295	1N4384
HR 1	HEATER 150 OHM	S-28043B	23732	S-28043B
HR 2	HEATER 46 OHM	S-28043B	23732	S-28043B
MP 1	GASKET		16231	2-241
MP 2	GASKET		16231	2-23
MP 3	MOUNT W/TBI	S-18007	23732	S-18007
MP 4	DRIVE W/C3	S-38019-2	23732	S-38019-2
MP 5	SHAFT MP4	S-18023-2	23732	S-18023-2

Table 6-1 (Continued)

REF DES	DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
RT 1	THERMISTOR		83186	41A11
RT 2	THERMISTOR		83186	41A11
RT 3	THERMISTOR		83186	41A11
TB 1	TERM BRD MP3		82229	2785-21-SS1

86-7-86 (SEPT'87)

Table 6-2

Federal Supply Code for Manufacturers

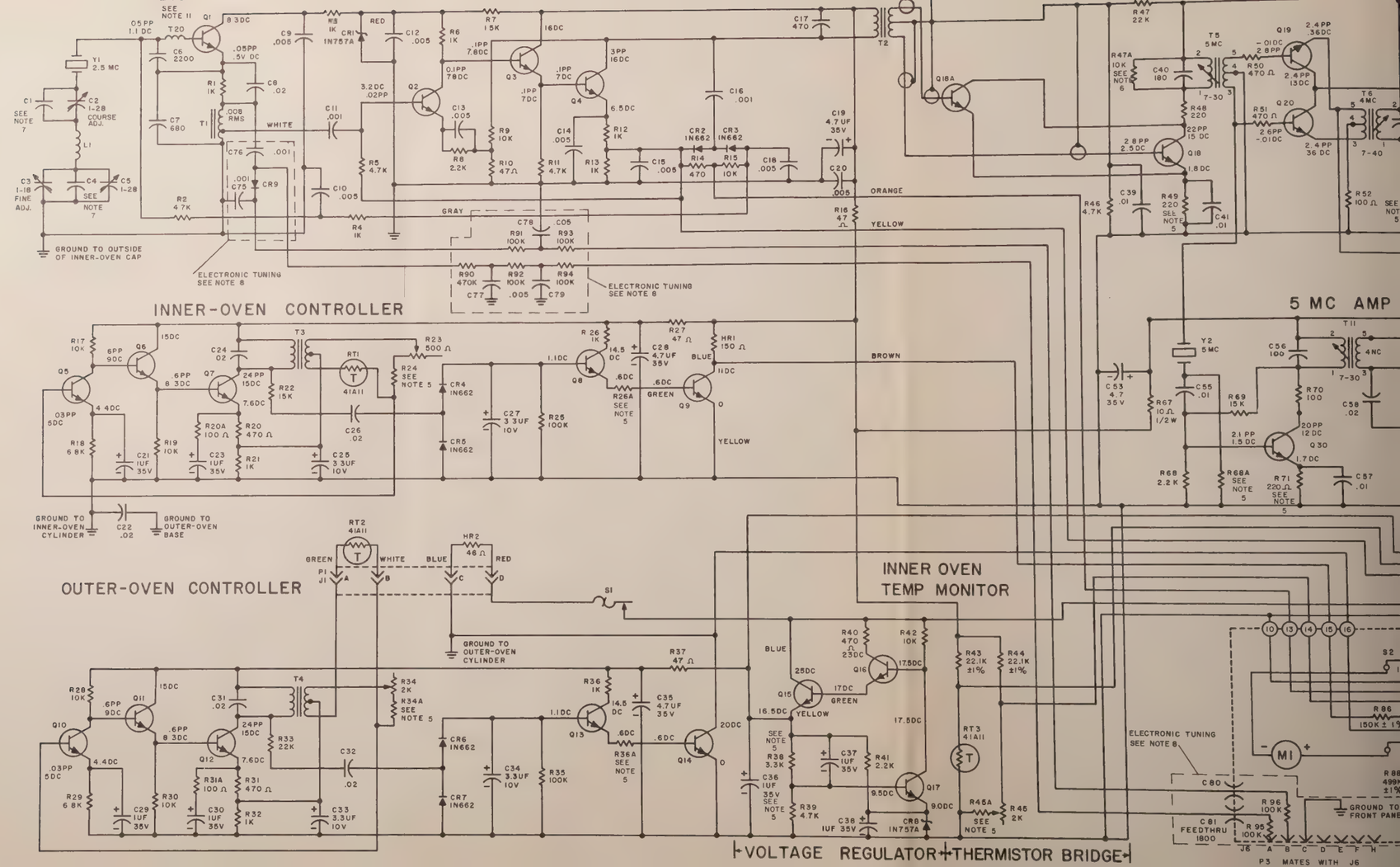
CODE NO.	MANUFACTURER	ADDRESS
00656	AEROVOX CORP	NEW BEDFORD, MASS 02741
01121	ALLEN-BRADLEY CO	MILWAUKEE, WISC 53204
01281	TRW SEMICONDUCTORS INC	LAWNDALE, CALIF 90260
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR-COMPONENTS DIV	DALLAS, TEX 75231
02111	SPECTROL ELECTRONICS CORP	CITY OF INDUSTRY, CALIF 91745
02114	FERROXCUBE CORP. OF AMERICA	SAUGERTIES, N Y 12477
02735	RADIO CORP OF AMER COMML REC TUBE AND SEMICONDUCTOR DIV	SOMERVILLE, N J
04713	MOTOROLA INC, SEMICONDUCTOR PRODUCTS INC	PHOENIX, ARIZONA 85008
06961	PIEZOELECTRIC DIV OF CLEVITE CORP	BEDFORD, O
16231	PARKER INSTRUMENT CORP	STAMFORD, CONN
23732	SULZER LABORATORIES DIV TRACOR INC	LOS ANGELES, CALIF 90045
38315	HONEYWELL INC PRECISION METER DIV	MANCHESTER, N H 03105
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MASS
71034	BLILEY ELECTRIC CO INC	ERIE, PA
71468	ITT CANNON ELECTRIC INC	LOS ANGELES, CALIF 90031
71590	CENTRALAB DIVISION OF GLOBE-UNION INC	MILWAUKEE, WISC 53212
73899	JFD ELECTRONICS CORP	BROOKLYN, N Y
76299	CORNING GLASS WORKS ELECTRONIC COMPONENTS DIV	RALEIGH, N C
80294	BOURNS INC	RIVERSIDE, CALIF 92506
80640	STEVENS ARNOLD INC	SOUTH BOSTON, MASS 02127
81073	GRAYHILL INC	LA GRANGE, ILL 60525
81312	WINCHESTER ELECTRONICS DIV LITTON INDUSTRIES INC	OAKVILLE, CONN
82229	HERMETIC SEAL CORP	ROSEMEAD, CALIF 91770
83186	VICTORY ENGINEERING CORP	SPRINGFIELD, N J 07081
83330	SMITH, HERMAN H. INC	BROOKLYN, N Y 11207
84171	ARCO ELECTRONICS INC	GREAT NECK, N Y 11022

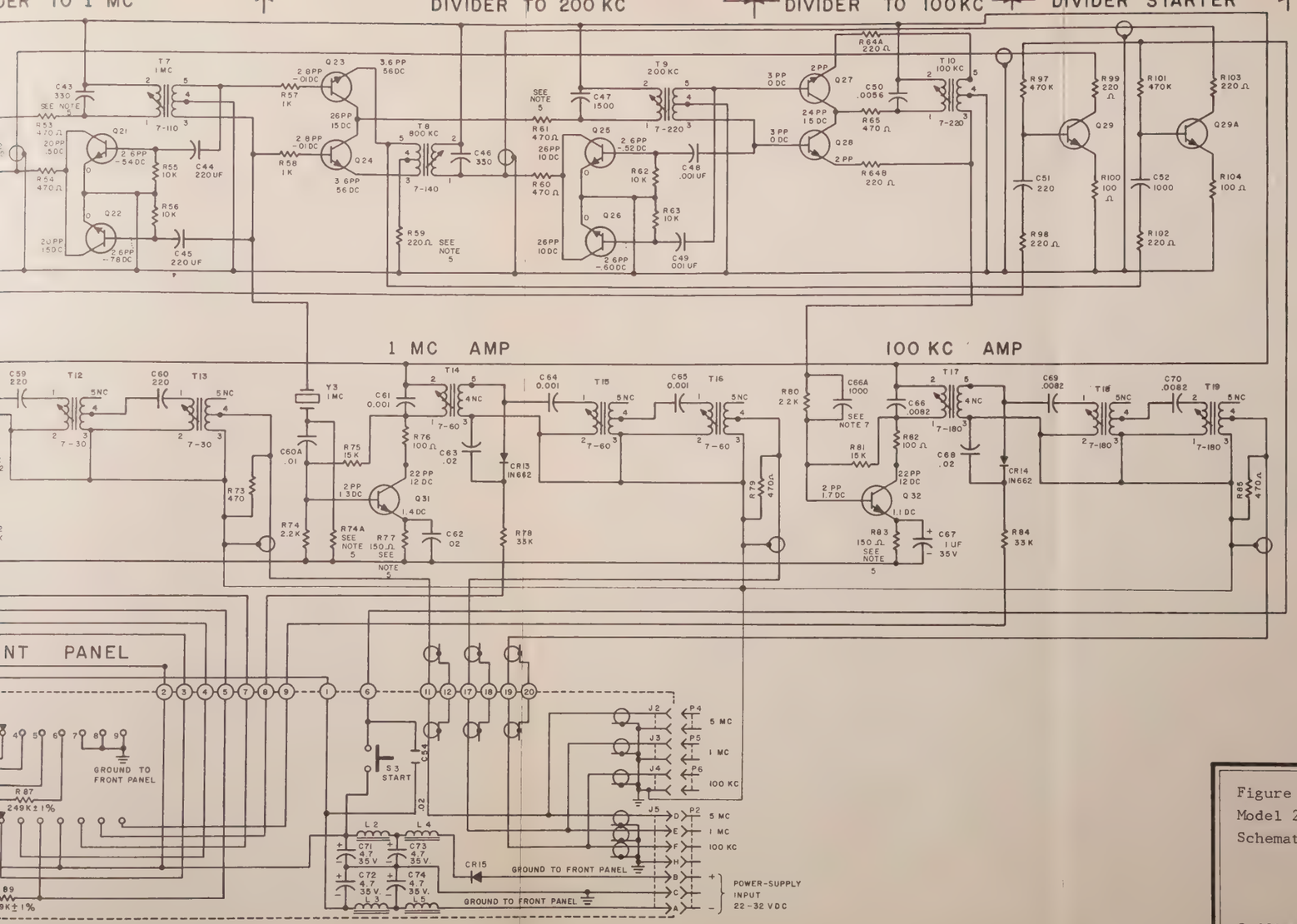
SECTION VII

DRAWINGS AND DIAGRAMS

7-1. SCOPE OF SECTION.

7-2. This section contains the schematic diagram of the frequency standard and an illustration showing the location of the adjustment and calibration points inside the frequency standard. The schematic diagram and illustration are referenced in sections IV (theory of operation) and V (maintenance).


INNER-OVEN CONTROLLER
OUTER-OVEN CONTROLLER
INNER OVEN TEMP MONITOR
5 MC AMP
VOLTAGE REGULATOR
THERMISTOR BRIDGE
ELECTRONIC TUNING SEE NOTE 8
GROUND TO OUTSIDE OF INNER-OVEN CAP
GROUND TO INNER-OVEN CYLINDER
GROUND TO OUTER-OVEN BASE
GROUND TO OUTER-OVEN CYLINDER
GROUND TO FRONT PANEL
P3 MATES WITH J6
WHITE
GRAY
ORANGE
YELLOW
BROWN
BLUE
GREEN
RED



NOTES:

1. TRANSISTOR TYPES AS FOLLOWS: Q1= 40235 , Q2 THRU Q4 & Q18 THRU Q32=2N2221, Q5 THRU Q13, Q16, Q17=2N697, Q14 & Q15=2N1701.
2. ALL RESISTANCES ARE IN OHMS ± 10% TOLERANCE, 1/4 WATT RATING UNLESS OTHERWISE STATED.
3. CAPACITANCE 1 OR GREATER ARE IN UUF UNLESS OTHERWISE STATED.
4. L1 IS USED TO SET FREQ CAPACITOR MAY BE USED IN SOME UNITS.
5. THE VALUES OF R24, R26A, R34A, R36A, R38, R39, R45A, R49, R52, R53, R59, R61, R68A, R71, R 74A, R77 & R83 ARE SELECTED DURING TEST.
6. R47A MAY BE OMITTED.
7. THE VALUES OF C1, C4 & C66A ARE SELECTED DURING TEST.
8. ELECTRONIC TUNING IS AN OPTIONAL FEATURE.
9. C75 THRU C81, R90 THRU R96, CR9 & J6 MAY BE OMITTED IN ALL MODELS WITHOUT ELECTRICAL TUNING.
10. A.C. AND D.C. VOLTAGE ARE MEASURED WITH RESPECT TO COMMON NEGATIVE LINE.
11. T20 INDUCTOR IS A BEAD TYPE

Figure 7-1. Frequency Standard, Model 2.5B and Model 2.5C Schematic Diagram S-69000 Rev -

S-69011 7-3/7-4

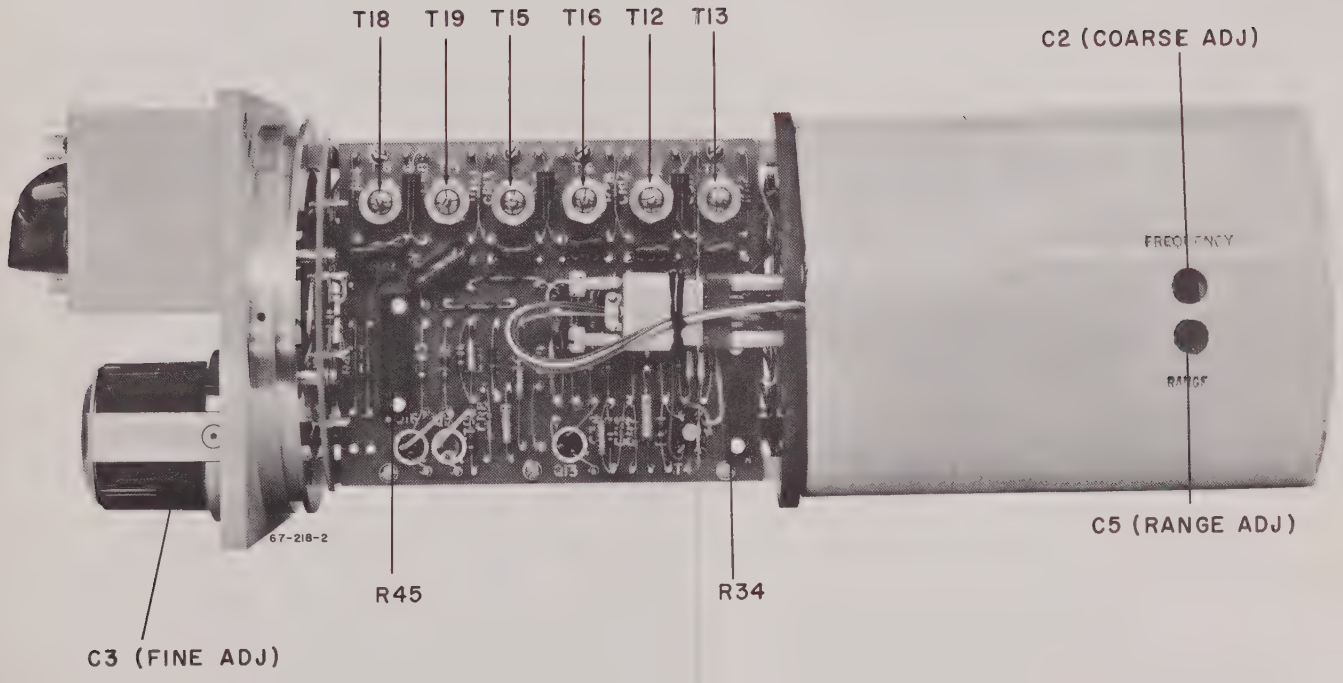


Figure 7-2. Frequency Standard Internal Adjustment Controls.

APPENDIX A

SULZER LABORATORIES POWER SUPPLY MODEL 5P OPERATION AND SERVICE MANUAL

A-1. INTRODUCTION.

A-2. This appendix contains the operation and service manual for the Power Supply Model 5P manufactured by Sulzer Laboratories Division, TRACOR, Inc.

OPERATION AND SERVICE MANUAL
POWER SUPPLY
MODEL 5P

SERIAL NO. _____ S-69014

September 1967

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WARRANTY

TRACOR, Inc. warrants each instrument it manufactures to be free from defects in material and workmanship. The obligation under this warranty is limited to repairing or replacing any instrument or part thereof that shall be returned to us by the original purchaser, transportation charges prepaid, when upon examination it is disclosed to our satisfaction to be defective. This warranty is effective for one year after delivery to the original purchaser. If the fault has been caused by misuse or abnormal conditions of operation, repair will be made at cost. In this case, an estimate will be submitted before work is started.

If any fault develops, notify TRACOR, Inc. and give full details, including model and serial numbers. You will then be notified as to the disposition of the defective instrument.

SULZER LABORATORIES DIVISION
9610 Bellanca Avenue
Los Angeles, California 90045
AC 213 / 670-5544

TRACOR

A6-106-76

INTRODUCTION

This manual contains the information necessary to operate and maintain the Power Supply Model 5P manufactured by Sulzer Laboratories Division, TRACOR, Inc. This information includes physical description, installation procedures, operating procedures, theory of operation, procedures for calibration, a parts list, and applicable drawings and diagrams required to provide adequate manual support.

This manual is to be used by all personnel operating or servicing the Power Supply.

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SECTION I
GENERAL DESCRIPTION

1-1. SCOPE OF SECTION.

1-2. This section describes the purpose and physical characteristics of the Sulzer Laboratories, Power Supply Model 5P and provides a brief description of the operating controls and indicators.

1-3. PURPOSE OF EQUIPMENT.

1-4. The Power Supply Model 5P provides direct current power, with battery backup, for the Frequency Standard Model 2.5B, Model 2.5C, or Model 5B.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The power supply (figure 1-1) is 4.5 inches high, 4.5 inches wide, 14.25 inches deep, and weighs approximately 12 pounds. When it is rack mounted with a frequency standard it is 5.25 inches high and 19 inches wide. It contains a rectifying and regulating circuit, a battery charging circuit, a low voltage cutoff circuit, and a 26.5 volt emergency backup battery. Refer to table 1-1 for a functional description of the power supply controls and indicators.

Figure 1-1. Power Supply Model 5P.

Table 1-1.

Power Supply Controls and Indicators

Name	Reference Designation	Function
POWER switch	S1	Applies 230 or 115 volts ac to rectifier circuit and applies internal battery voltage to regulator circuit.
POWER lamp	DS1	Lights when power supply is connected to ac power and POWER switch is on.
CHARGING RATE switch	S2	In HIGH position, applies rectifier output voltage to battery, through two parallel resistors, to provide 400 milliampere charging rate.
HIGH lamp	DS2	Lights when battery is being charged at 400 milliampere rate.
START pushbutton	S3	Momentarily bypasses battery cutoff circuit to provide dc output when power supply is first turned on and ac power is not present.

SECTION II
INSTALLATION

2-1. SCOPE OF SECTION.

2-2. This section provides instructions for installation of the power supply.

2-3. INSTALLATION.

2-4. Carefully unpack and examine the power supply for possible damage during shipment. Special attention should be given to areas where the outside shipping package was damaged.

2-5. RACK MOUNTING. The power supply can be factory mounted in an optional 19 inch rack panel with a frequency standard. If the power supply is not factory mounted, it can be mounted in any suitable rack panel or cabinet. Refer to figure 2-1 for a template of the panel cutout required to mount the power supply. The power supply fastens to the rack panel with four 10-24 screws in its front panel.

2-6. If the power supply will be used as a mobile unit, the optional rear clamp (part Number S-38181-1) should be used to support the rear of the power supply. The rear clamp must be supported with two side plates fastened between the panel and the rear clamp. The distance the rear clamp is positioned from the panel is not critical and can be changed to meet different mounting requirements.

2-7. POWER CONNECTIONS. The power supply, when factory mounted with the frequency standard, should be already connected to the frequency standard. Check that power supply cable is securely connected to connector J5 on rear of frequency standard.

S-69014

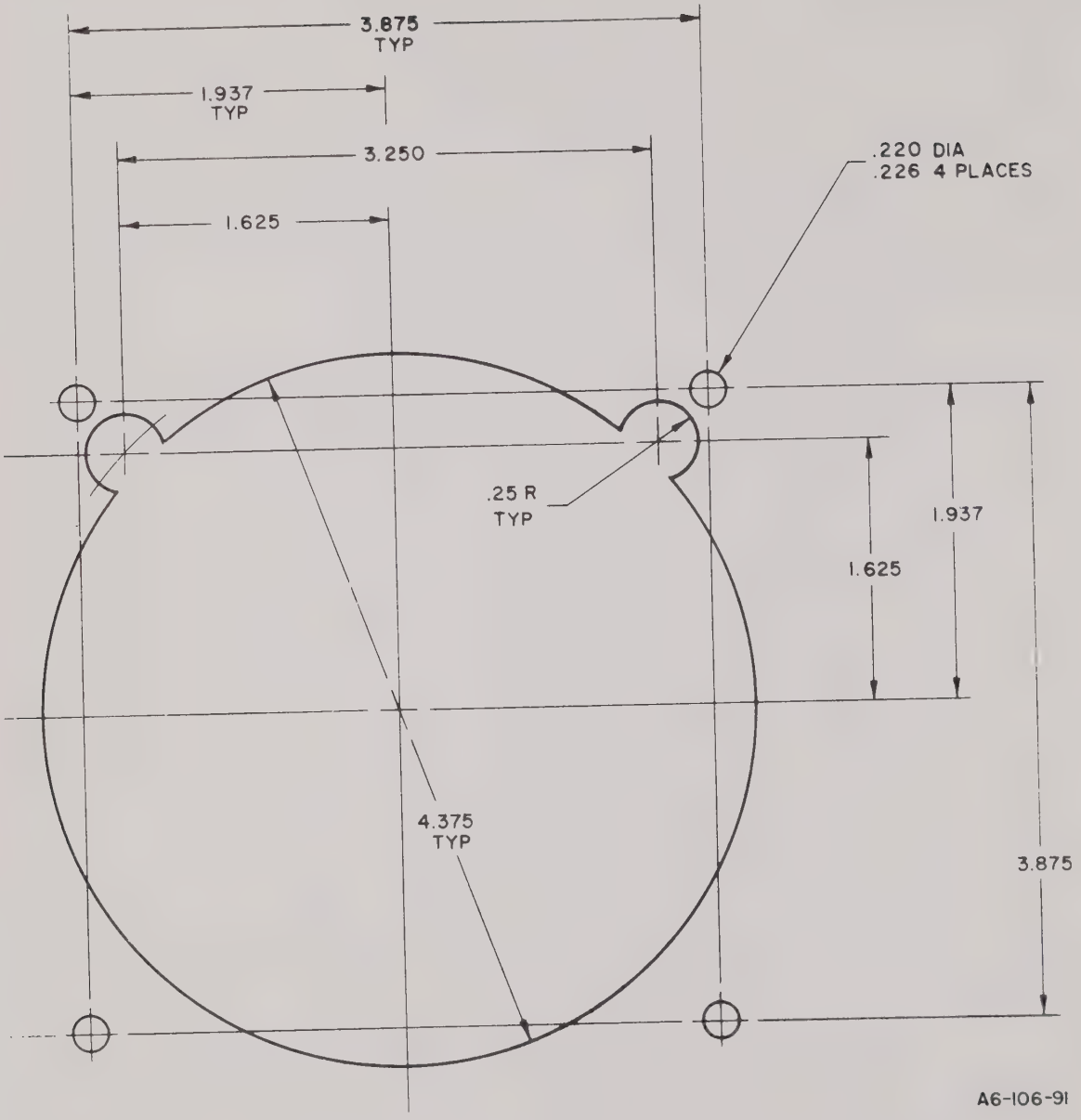

Figure 2-1. Rack Panel Mounting Template.

2-8. If the power supply is not factory mounted, the power supply cable supplied must be connected between the frequency standard and the power supply.

2-9. OPERATION ON 230 VOLT AC POWER. The power supply is factory wired for operation on 115 volt ac power, but can be modified to operate on 230 volt ac power. Modify the power supply as follows:

a. Remove outer cylindrical container from power supply.
b. Remove jumper connected between terminals 1 and 3 on transformer T1.
c. Remove jumper connected between terminals 2 and 4 on transformer T1.
d. Connect jumper between terminals 2 and 3 on transformer T1.
e. Reassemble power supply.
f. Mark outside of power supply near facility power cord as follows: THIS UNIT WIRED FOR 230 VOLT OPERATION.

2-10. INITIAL BATTERY CHARGE. The power supply is shipped with the battery discharged 70 percent. Initially recharge the battery as follows:

CAUTION

Do not charge the battery at the high rate for longer than 14 hours. This causes excessive outgassing, reducing the electrolyte level enough to cause the battery to fail.

a. Set CHARGING RATE switch to HIGH. HIGH lamp shall light.
b. Allow battery to charge at high rate for 10 hours.
c. Set CHARGING RATE switch to normal position. HIGH lamp shall go out.

NOTE

The power supply can be used to provide power for the frequency standard while the battery is being recharged.

2-11. Power supply is now ready for use.

SECTION III
OPERATION

3-1. SCOPE OF SECTION.

3-2. This section provides detailed procedures for operation of the power supply.

3-3. EQUIPMENT TURN ON.

3-4. Turn on power supply as follows:

a. Connect power supply to ac facility power.

b. Set POWER switch on. POWER lamp will light.

c. Check that CHARGING RATE switch is not in HIGH position and that HIGH lamp is not lighted.

3-5. OPERATION.

3-6. The power supply does not require operation procedures after turn on. If ac power is lost, the power supply will automatically switch to its internal battery. The battery will provide power for the frequency standard for a minimum of 10 hours at 25 degrees C.

3-7. BATTERY RECHARGE. The battery charging circuit will automatically recharge the battery when ac power is restored.

3-8. If the battery has been used for more than 2.5 hours recharge the battery at the high rate for 4 hours as follows:

CAUTION

Do not charge the battery at the high rate for longer than 14 hours. This causes excessive outgassing, reducing the electrolyte level enough to cause the battery to fail.

a. Set CHARGING RATE switch to HIGH. HIGH lamp shall light.

b. Allow battery to charge at high rate for 4 hours.

c. Set CHARGING RATE switch to normal position. HIGH lamp shall go out.

NOTE

The power supply can be used to provide power for the frequency standard while the battery is being recharged.

3-9. If the battery has been used until the cutoff circuit disconnects the battery from the load, recharge the battery at the high rate as specified in paragraph 3-8 for 14 hours instead of 4 hours.

3-10. If the power supply will be used as a mobile unit, the battery should be charged at the high rate as specified in paragraph 3-8 before ac power is removed. This will insure that maximum capacity can be supplied by the battery.

SECTION IV
THEORY OF OPERATION

4-1. SCOPE OF SECTION.

4-2. This section provides a general description of the overall operation of the power supply and detailed analysis of its individual circuits.

4-3. FUNCTIONAL ANALYSIS.

4-4. The power supply can be divided into three main operational sections; the rectifying and regulating section, the battery charging section, and the battery and low voltage cutoff section. Refer to figure 4-1 for a functional block diagram and to figure 7-1 for a schematic diagram of the power supply.

4-5. RECTIFYING AND REGULATING SECTION. The rectifying and regulating section consists of an input power transformer, a diode bridge, and a voltage regulator. The bridge converts 115 volts ac, or 230 volts ac, to approximately 37 volts dc.

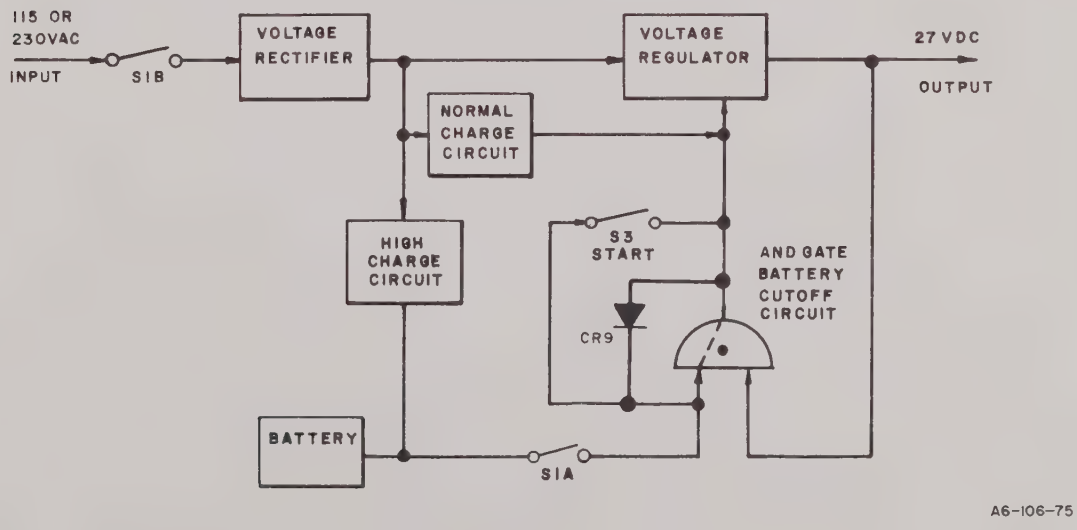

Figure 4-1. Power Supply Functional Block Diagram.

The voltage regulator stabilizes this voltage using the battery voltage as a reference. The 27 volt output of the voltage regulator is used as the power supply output.

4-6. BATTERY CHARGING SECTION. The battery charging section consists of two battery charging circuits, a normal charge circuit and a high charge circuit. The normal charge circuit is always connected to the battery and maintains a 50 milliampere charge current on the battery at all times until the battery is fully charged. The high charge circuit can be manually switched on between the rectifier output and the battery. This circuit produces a 400 milliampere charge current. This is only used after the battery has been used for more than 2.5 hours or before the power supply will be used where ac power is not available.

4-7. BATTERY AND LOW VOLTAGE CUTOFF SECTION. The battery and low voltage cutoff section consists of a 21 cell, 26.5 volt, sealed nickel cadmium battery and its associated low voltage cutoff circuit. The battery supplies the reference for the voltage regulator to provide a stable dc output when ac power is being used. If ac power is lost, the battery provides the dc output, through the voltage regulator.

4-8. The low voltage cutoff circuit contains a relay that deenergizes when the battery voltage drops below 21 volts. This disconnects the battery from the voltage regulator to prevent the battery from reversing its potential when it is discharged. The circuit also has a bypass switch that energizes the low voltage cutoff relay. This allows the battery to be used when ac power is not present to apply the dc power to the frequency standard. However, this will not function if the battery voltage is below 21 volts.

4-9. DETAILED THEORY OF OPERATION.

4-10. The power supply contains a voltage rectifier, a voltage regulator, a battery, a low voltage cutoff circuit, a normal charge circuit, and a high charge circuit.

4-11. VOLTAGE RECTIFIER. The voltage rectifier converts the 115 volt ac input power, coupled through power transformer T1, to 27 volts dc power. The rectifier bridge consists of diodes CR1, CR2, CR3, and CR4. Capacitor C1 across the bridge output reduces ripple. This output is used by the voltage regulator and the normal and high charge circuits.

4-12. VOLTAGE REGULATOR. The voltage regulator, transistor Q1, stabilizes the rectifier output at 27 volts dc. The voltage rectifier output is applied to the collector of transistor Q1 as the voltage regulator input. The voltage regulator output at the emitter of transistor Q1 is controlled by the dc current from the battery. The current is applied to the base of transistor Q1 through diode CR7. If the voltage regulator output is low, the base current of transistor Q1 increases. By increasing the base current, the voltage drop across transistor Q1 decreases. This increases the voltage regulator output.

4-13. If ac power is lost, the battery supplies dc power, through the base of transistor Q1, to the power supply output. Since the base emitter junction of transistor Q1 is always forward biased, there is no switching transient from ac to battery power.

4-14. LOW VOLTAGE CUTOFF CIRCUIT. The low voltage cutoff circuit consists of relay K1, transistor Q3, zener diode CR8, and the voltage divider network consisting of resistors R6 and R8 and potentiometer R7.

4-15. The battery voltage is applied to the voltage divider network and to the normally open contact of relay K1. Potentiometer R7 selects a portion of the battery voltage dropped across the divider network and applies it to zener diode CR8. Potentiometer R7 is adjusted so that zener diode CR8 conducts as long as the battery voltage is greater than 21 volts. When zener diode CR8 conducts, transistor Q3 turns on, applying a ground to the coil of relay K1. The voltage regulator output energizes

relay K1, which applies the battery voltage to the voltage regulator.

4-16. When ac power is lost, the battery power, through the voltage regulator, keeps relay K1 energized. As the battery discharges its voltage decreases. When the battery voltage decreases to 21 volts, zener diode CR8 stops conducting, transistor Q3 turns off, and relay K1 deenergizes. This removes the battery power from the voltage regulator.

4-17. When the power supply is used where ac power is not available, START switch S3 is used to bypass relay K1 contacts. This applies the battery power to the voltage regulator which energizes relay K1. The circuit then functions as stated in paragraphs 4-15 and 4-16.

4-18. Diode CR5 prevents the battery voltage from lighting the POWER lamp, which would use a portion of the battery capacity. Diode CR9 is an arc suppression diode that protects the contacts of relay K1.

4-19. NORMAL CHARGE CIRCUIT. The normal charge circuit provides a 50 milliampere charging current to recharge and to maintain the battery at full capacity. It consists of transistor Q2 resistors R3 and R4, and diode CR6. Transistor Q2 regulates the charging current being applied to the battery. Zener diode CR6 maintains the correct potential across the charger circuit, which is approximately 5 volts dc.

4-20. HIGH CHARGE CIRCUIT. The high charge circuit provides a 400 milliampere charging current to recharge the battery after it has been used for more than 2.5 hours. CHARGING RATE switch S2 switches two parallel connected resistors into the circuit between the voltage rectifier output and the battery. These two resistors, R5A and R5B, regulate the charging current at 400 milliamperes. Diode CR10 prevents the charging circuit from discharging the battery, through HIGH lamp DS2, if the CHARGING RATE switch is set to HIGH while the battery output is being used.

SECTION V
MAINTENANCE

5-1. SCOPE OF SECTION.

5-2. This section provides all procedures required to maintain the power supply.

5-3. TROUBLE ANALYSIS.

5-4. Because of the simplicity of the design of the power supply, trouble analysis procedures are not required. Refer to the schematic diagram (figure 7-1) to aid in trouble shooting if the power supply does not operate properly.

5-5. MAINTENANCE.

5-6. To insure reliable operation the battery should be replaced once a year. The battery is a sealed unit and cannot be serviced; if it does not produce the specified capacity, it should be replaced.

WARNING

The safety vents on the battery must never be plugged or covered. This can cause pressure buildup in the battery as it outgasses during its charge cycle. Excessive pressure buildup can cause the battery to explode.

5-7. The power supply requires no other maintenance.

SECTION VI
REPLACEABLE PARTS

6-1. SCOPE OF SECTION.

6-2. This section provides all necessary information for quick identification of replaceable parts for the power supply. The section contains a list of replaceable parts and a numeric list of federal supply codes for manufacturers.

6-3. LIST OF REPLACEABLE PARTS.

6-4. A list of replaceable parts for the power supply is presented in table 6-1. Information in the table includes the reference designation, part description, Sulzer Laboratories stock number, federal supply code for manufacturers (FSCM), and manufacturer part number, presented in that order.

6-5. REFERENCE DESIGNATION. The reference designation is an alpha-numeric identification assigned to each assembly and to electrical components within an assembly. Reference designations are obtained by referring to the schematic diagram (figure 7-1) or by markings on the assembly.

6-6. PART DESCRIPTION. All parts are described using the noun-modifier method. For example, a 2500 ohm variable resistor is described as: RES VAR 2X5 K. The "X" between the "2" and the "5" represents the position of the decimal.

6-7. SULZER LABORATORIES STOCK NUMBER. A Sulzer Laboratories stock number is assigned to replaceable parts in the power supply. Identical parts have identical stock numbers. Presently, only replaceable parts manufactured or assembled by Sulzer Laboratories have a stock number assigned to them.

6-8. FEDERAL SUPPLY CODE FOR MANUFACTURERS.

6-9. A list of manufacturers supplying parts for the power supply is provided in table 6-2. Information in the table includes the manufacturer federal supply code number, manufacturer's name, and manufacturer's address, presented in that order. The manufacturers are listed in numerical order by

federal supply code number.

6-10. To locate the manufacturer of a part, proceed as follows:

a. Obtain the manufacturer federal supply code number by referring to the List of Replaceable Parts (table 6-1).

b. Locate the federal supply code number in the appropriate column of the Federal Supply Code for Manufacturers (table 6-2).

6-11. ORDERING INFORMATION.

6-12. Address orders or inquiries to either an authorized Sulzer Laboratories Sales Representative or to:

Customer Service
Sulzer Laboratories Division,
TRACOR, Inc.
9610 Bellanca Avenue
Los Angeles, California 90045

6-13. To insure prompt service, orders must include the following information:

a. Name, model, and serial number of the instrument.

b. Reference designation, if applicable.

c. Sulzer Laboratories stock number, if one is assigned.

d. Full description of the part.

6-14. Item a. is located on the instrument; and items b., c., and d. are found in the List of Replaceable Parts (table 6-1).

6-15. The part numbers shown will change occasionally as manufacturers' items are reevaluated or as improved components become available. The component shipped will be the component used in production at the time the order is received, and will be equivalent to the component it replaces in both dimensions and performance.

6-16. The minimum billing on any order is $15.00, with a standard delivery of 30 days. All prices are FOB Los Angeles, California, and are subject to change without notice.

Table 6-1
List of Replaceable Parts

REF DES		DESCRIPTION	SULZER LABS STOCK NO.	FSCM	MFR PART NO.
C	1	CAP ELEC 300 MFD		00656	CE51C301G
F	1	FUSE SLOW .5 AMP		71400	
F	2	FUSE FAST 1 AMP		71400	
K	1	RELAY DPDT 5 K		02288	JSH-6D
Q	1	TSTR NPN 2N1701		02735	2N1701
Q	2	TSTR NPN 2N1701		02735	2N1701
Q	3	TSTR NPN 2N697		01295	2N697
R	1	RES FXD COMP 680 OHM		01121	RC32
R	2	RES FXD COMP 680 OHM		01121	RC32
R	3	RES FXD COMP 1 K		01121	RC32
R	4	RES FXD COMP 100 OHM		01121	RC42
R	5	RES FXD WW SLCD		14841	10XM20
R	6	RES FXD WW 6X8 K		14841	RC07
R	7	RES VAR 2X5 K		12697	48M9-2500
R	8	RES FXD WW 4X7 K		01121	RC07
R	9	RES FXD WW 10 K		01121	RC07
S	1	SWITCH TOGGLE DPST		31356	ST22K
S	2	SWITCH		81073	30-1
S	3	SWITCH TOGGLE DPST		31356	ST22K
T	1	XFMR	6-R1A	23732	6-R1A
BA	1	NI-CAD BATTERY PACK	BA-1	23732	BA-1
CR	1	DIODE 1N4384		01295	1N4384
CR	2	DIODE 1N4384		01295	1N4384
CR	3	DIODE 1N4384		01295	1N4384
CR	4	DIODE 1N4384		01295	1N4384
CR	5	DIODE 1N4384		01295	1N4384
CR	6	DIODE 1N751A		01295	1N751A
CR	7	DIODE 1N4384		01295	1N4384
CR	8	DIODE 1N960		01295	1N960
CR	9	DIODE 1N4384		01295	1N4384
DS	1	LAMP MINAT 28 V		71744	327
DS	2	LAMP MINAT 28 V		71744	327
MP	1	NOT USED			
MP	2	GASKET		16231	2-237
MP	3	GASKET		16231	2-23
MP	4	MOUNT TB1	S-18007	23732	S-18007
TB	1	HEADER		82229	2785-21-SS1
XC	1	XTAL SOCKET		91662	TS 101P01
XF	1	FUSEHOLDER		75915	342004
XF	2	FUSEHOLDER		75915	342004
XDS	1	LAMPHOLDER WHT LENS		72619	101-3830-935
XDS	2	LAMPHOLDER RED LENS		72619	101-3830-931

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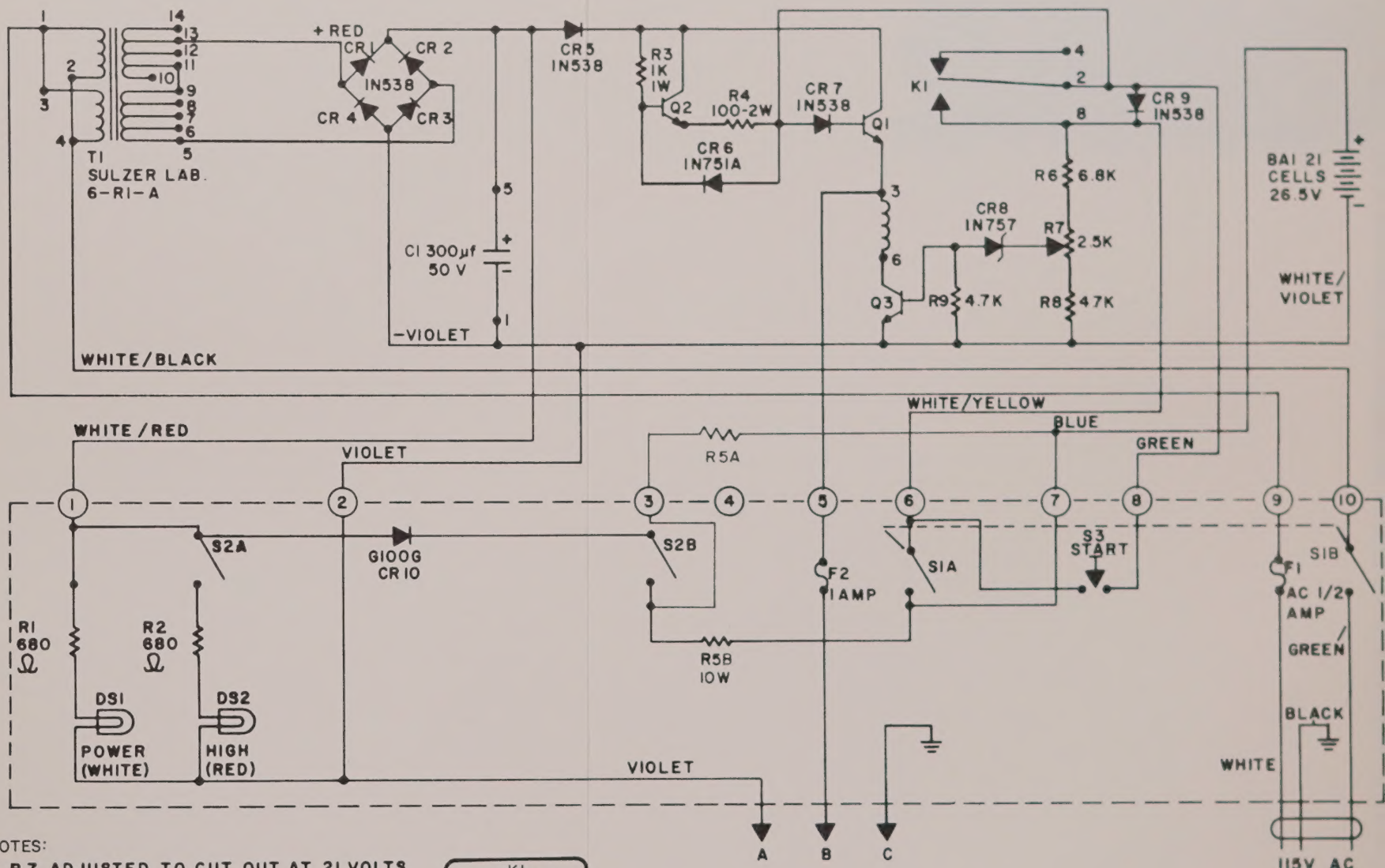
Table 6-2
Federal Supply Code for Manufacturers

CODE NO.	MANUFACTURER	ADDRESS
00656	AEROVOX CORP	NEW BEDFORD MASS 02741
01121	ALLEN-BRADLEY CO	MILWAUKEE, WISC 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR-COMPONENTS DIV	DALLAS, TEX 75231
02288	ALLIED CONTROL CO INC	PLANTSVILLE, CONN 10021
02735	RADIO CORP OF AMER COMML REC TUBE AND SEMICONDUCTOR DIV	SOMERVILLE, N J
12697	CLAROSTAT MFG CO INC	DOVER, N H 03820
14841	WARD LEONARD ELECTRIC CO	HAGERSTOWN, MD 21741
16231	PARKER INSTRUMENT CORP	STAMFORD, CONN
23732	SULZER LABORATORIES DIV TRACOR INC	LOS ANGELES, CALIF 90045
31356	JBT INSTRUMENTS INC	NEW HAVEN, CONN 06508
71400	BUSSMANN MFG DIV OF MCGRAW-EDISON CO	ST. LOUIS, MO
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO, ILL 60640
72619	DIALIGHT CORP	BROOKLYN, N Y
75915	LITTELFUSE INC	DES PLAINES, ILL 60016
81073	GRAYHILL INC	LA GRANGE, ILL 60525
82229	HERMETIC SEAL CORP	ROSEMEAD, CALIF 91770
91662	ELCO CORP	WILLOW GROVE, PA

SECTION VII
DRAWINGS AND DIAGRAMS

7-1. SCOPE OF SECTION.

7-2. This section contains the schematic diagram of the power supply. The schematic diagram is referenced in sections IV (theory of operation) and V (maintenance).



NOTES:

1. R7 ADJUSTED TO CUT OUT AT 21 VOLTS.
2. Q1, Q2 2N1485 OR 2N1701
3. Q3 2N697.
4. CR7 MAY BE OMMITTED.
5. R5B SELECTED 200HMS APPROXIMATELY.
6. R5A SELECTED VALUE.

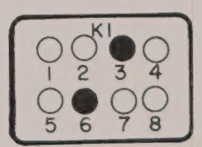


Figure 7-1. Power Supply,
Model 5P Schematic Diagram
S-19002 Rev -

S-69014 7-3/7-4